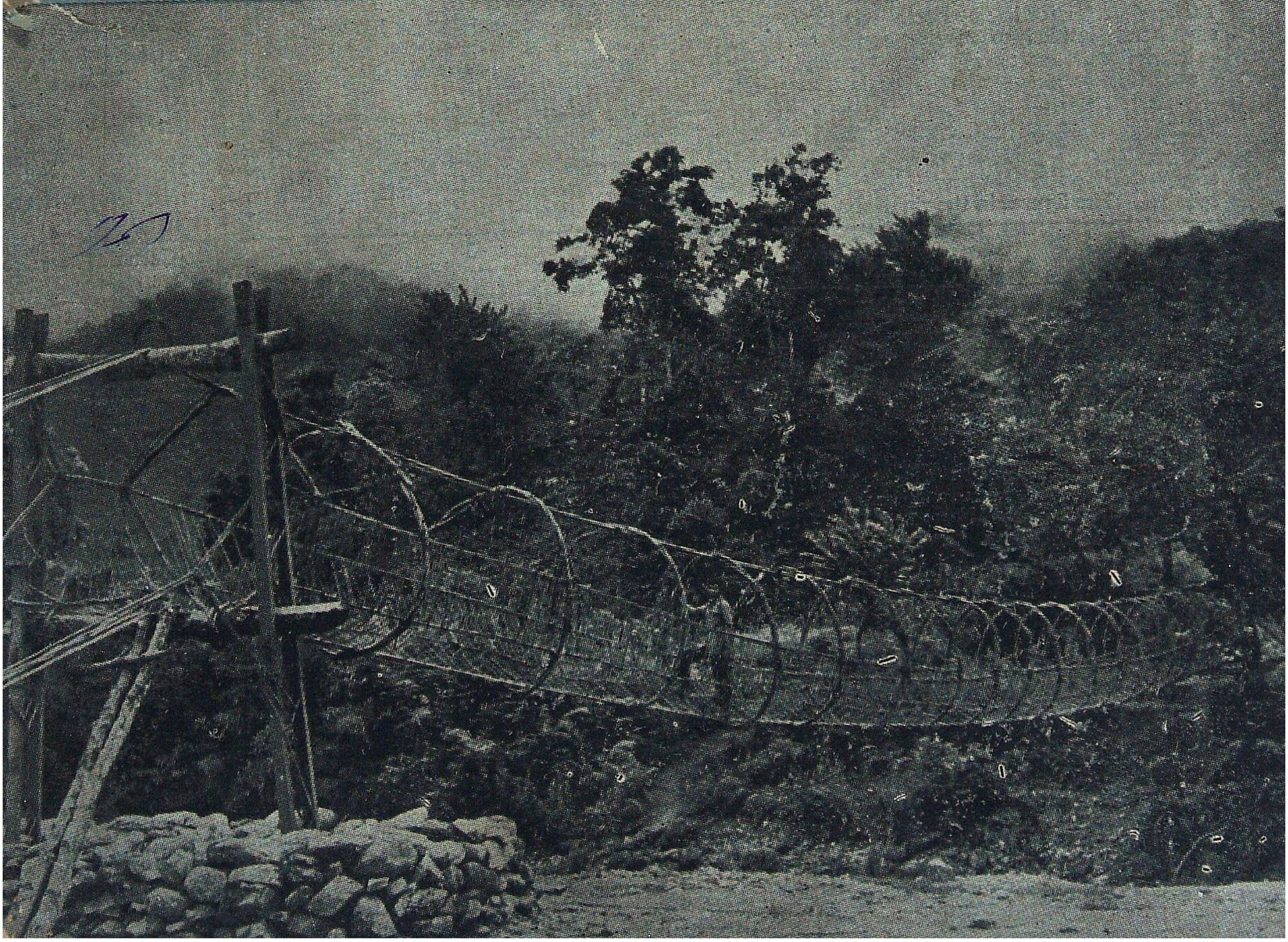
JUNE, 1983

THE INDIAN FORESTER

FOUNDED IN 1875

P. 100
5.81



Telegram : Indian Forester Telephone: 27021/264

INDIAN FORESTER

(A Monthly Journal of Forestry and Forestry Research)

BOARD OF MANAGEMENT

Chairman—N.D. Bachkheti, I.F.S., Inspector General of Forests, New Delhi.
Vice Chairman—K.M. Tiwari, I.F.S., President, Forest Research Institute & Colleges, Dehra Dun.

MEMBERS

Andamans : W.B. BATHEW, I.F.S.; Andhra Pradesh : A.K. MATHUR, I.F.S.; Arunachal Pradesh : R.N. KAUL, I.F.S.; Assam: S. RAJKHOWA, I.F.S.; Bihar : J.N. PANDEY, I.F.S.; Dadar & Nagarhaveli : K.D. SINGH, I F S.; Goa : P.P MALHOTRA, I.F.S.; Gujarat : M.S. KHANCHANDANI, I.F.S.; Haryana : GURNAM SINGH, I.F.S.; Himachal Pradesh: V.K. SHARMA, I.F.S.; Jammu & Kashmir: G. R. SUFI, I.F.S. Karnataka : SHYAM SUNDER, I.F.S.; Kerala : A. HASSANKUTTY, I.F.S.; Maharashtra M.Y. SOWANI, I.F.S.; Madhya Pradesh : V.K. SETH, I.F.S.; Manipur : B.S.K. SARMA, I F.S.; Meghalaya PS. INGTY, I.F.S.; Mizoram : A.K, CHOWDHARY, I.F.S.; Nagaland : D.K. ZELIANG, I.F.S.; Orissa S.N. DAS, I.F.S.; Punjab (I) : A.S. SIDHU, I.F.S.; Rajasthan : K.K. GUPTA, I.F.S.; Sikkim : P.O. PAZO, I.F.S Tamil Nadu : T. ACHAYA, I.F.S.; Tripura : A.K. GHOSH, I.F.S.; Uttar Pradesh : C.L. BHATIA I.F. West Bengal : P.K. RAY, I.F.S.

RULES OF MANAGEMENT

1. *Pre-payable Annual Subscription* :—

INDIA	FOREIGN	SINGLE COPY (Current and Back issu
(Inclusive of Postage)		(Exclusive of Postage)
Rs. 100.00,	£ 25 00 or $ 50.00 (By Sea Mail)	India Rs. 10.00, Foreign $ 5.00 or £ 2.50
	£ 40.00 or $ 80.00 (By Air Mail)	

Note :—Subscriptions are generally booked for a Calendar Year (JANUARY-DECEMBER), and/or fr JULY-JUNE. Copies for intermediate months (of current issue) can, however, be supplied on payme if available.

2. *Concessional Rates of Annual Subscription* (Applicable to Serving Forest Officers & Forest Scientis in Government Institutes and Government Departments in India only) :—

(a) Those drawing a Salary of less than Rs. 500 p.m. ... ...Rs. 50.00 per Annum
(b) „ „ „ „ Rs. 700 „ ... ...Rs. 60.00 „ „

3. *Life Subscription* :—Forest Officers, on retirement from service in India, can obtain copies of the *Indian Forester* for life by one Single Payment of Rs. 300.00 or its equivalent. A life Subscriber will be enrolled as such hand entitled to receive copies of the Journal from the date of receipt of the full amount of his Life subscription. Request for back numbers of the Journal will not be entertained. These can, however, be supplied, if available, on payment fixed for back numbers.

4. *Advertisement Tariff* :—(The rates are exclusive of blocks, etc. and are liable to change WITHOUT NOTICE). All Advertisement Matter is strictly subject to the approval of the Management.

N.B.—The Table below shows Contract Rates for and over SIX and TWELVE Insertions respectively to be consumed in one YEAR or THREE Insertions booked at a time and printed in three successive Issue of the Journal. The figures in the right-hand column denote Charges for Casual and Single Insertions.

space	12 Insertions	6 Insertions	3 Insertions	Casual (Per Insertion)
Full Page	Rs. 1500.00	Rs. 800.00	Rs. 450.00	Rs. 150.00
Half Page	Rs. 900.00	Rs. 500.00	Rs. 300.00	Rs. 100.00
Quarter Page	Rs. 600.00	Rs. 350.00	Rs. 225.00	Rs. 80.00
2.5 cm Across Page	Rs. 500.00	Rs. 300.00	Rs. 200.00	Rs. 70.00

Note :—(1) Extra charges over the above Rates for (*a*) Multi-Colour Insertions (up to four colour only) 75% (*b*) Double-colour (Red only or Red and Black)—25%; (*c*) Advertisement on Art Paper—25%
(2) Half-tone and Line Blocks, Stereos, and Matrices accepted. Blocks of all description and/or other Advertisements material are to be supplied by the Advertising parties themselves.
(3) screen used for Advertisements : 80—100.
(4) Only one *Voucher Copy* will be applied Overall Size : 24 cm × 18.5 cm; Printing Size (Full-page) 20 cm × 15 cm.

Important—(*a*) Advertisement charges are strictly Payable in advance preferably by a bank Draft on State Bank of India, Dehra Dun, U.P. (India); and drawn in favour of the Business Manager *Indian Forester* (*b*), The Advertisement matter, which should be TYPEWRITTEN in BLOCK LETTERS or ITALICS, must reach us EIGHT WEEKS (10 WEEKS in case of multi-colour insertions) before the appearance of an issue for wh ich an advertisement is intended, and should always be sent in DUPLICATE. For further particulars and of terms business please apply to the Business Manager, *Indian Forester*.

(5) Correspondence concerning subscriptions, etc., should be addressed to the Business Manager, *Indian Forester*, P.O. New Forest, Dehra Dun (India). All payments on account of Subscriptions and Advertisement, etc., must, however, be made in the name of the Business Manager, *Indian Forester*, and Chequ es, etc., drawn in his favour.

(6) All complaints regarding delay in receipt or non-delivery of a copy or copies of the *Indian Forester* should be made WITHIN 30 DAYS from the due date of publication of an issue which is 1st of each month to the Business Manager, *Indian Forester*, P.O. New Forest, Dehra Dun. Efforts will be made to supply duplicate copy or copies of the missing number, *free of cost*, provided a complaint is received in time, and on payment if a complaint as received after 30 days subject to the availability of a copy or copies in stock in their case.

(7) In case of dispute, Dehra Dun, U.P. (India), shall be the place of jurisdiction.

VOLUME 109 NUMBER 6

THE

INDIAN FORESTER

JUNE, 1983

PLYWOOD INDUSTRY OF INDIA AND EXPORT PROSPECTS

S.R. SAGAR, AND M.Y. ANSARI

Forest Economics Branch,

Forest Research Institute and Colleges, Dehra Dun

The plywood production in India started around Twenties with sole purpose of meeting requirements of plywood for tea-chest. The plywood industry started as small scale units; in the beginning was handmade of Packaging Industry. The tea-chest plywood of 3-ply was first adopted in the Indian Tea trade in 1905 as imported item. Soom it started being preferred over wooden boxes of solid sawn wood (planks of about ½" thickness) used for tea packing resulting in an increased import of plywood for teachest. About 3.0 millions of rupees worth of Tea-chest plywood was imported annually between the period 1905-1910, this increased to Rs. 5.73 million worth in 1921-22, and further stepped upto Rs. 9.0 million worth in 1924–25. This rising trend of import continued upto 1951-52 when plywood worth Rs.14.54 million was imported. The indigenous production of plywood mainly tea-chest started in 1924. By 1960, the indigenous production increased to such an extent that the import of plywood reduced to negligible quantity. India in 1961-62 not only became self sufficient in domestic consumption but also emerged on the export map of the World.

The trend of growth of plywood production from 1961 to 1979 is given in Table 1.

A sizeable part of indigenous production of plywood both tea-chest and commercial is consumed for domestic requirements. The plywood is being preferred over sawn wood due to its inherent qualities such as dimensional stability, homogeneousness, built-in finishes viz. water proofing, fire proofing, insect proofing etc.

The tea-chest plywood is used for tea packaging required for domestic and foreign tea trade and other freight containers. The commercial and decorative plywood is being used in construction usually for panelling, shuttering and framework, flush doors and decorative purposes. In addition the plywood is increasingly used in ship and boat-building (interior

Table 1

Growth of Capacity Utilization of Plywood Industry

Sl. No.	Year	Installed capacity million m²	Production of plywood million m² (4 mm basis)			% Growth over previous year
			Tea-chest plywood	Commercial plywood	Total	
1	2	3	4	5	6	7
1	1961[a]	30.10	9.04	6.32	15.36	—
2	1962[a]	34.47	9.78	7.48	17.26	12.37
3	1963[a]	34.47	10.39	10.04	20.43	18.37
4	1964[a]	34.37	9.75	10.63	20.38	(—) 0.24
5	1965[e]	34.47	10.40	12.37	22.77	11.73
6	1966[a]	36.60	9.66	12.67	22.33	(—) 1.93
7	1967[a]	36.60	10.87	14.30	25.27	13.17
8	1968[a]	36.60	11.58	16.84	28.42	12.46
9	1969[a]	36.75	8.87	19.18	28.05	(—) 1.30
10	1970[a]	36.75	4.32	18.41	22.73	(—) 18.97
11	1971[a]	43.00	4.95	22.59	27.54	21.16
12	1972[a]	43.00	3.64	28.34	32.58	18.30
13	1973[a]	43.00	3.36	30.27	33.63	3.22
14	1974[a]	43.00	3.30	32.34	35.64	5.98
15	1975[b]	43.00	3.37	28.42	31.79	(—) 10 80
16	1976[b]	54.26	2.39	32.79	35.18	10.66
17	1977[c]	61.81	N.A.	N.A.	39.80	13.13
18	1978[c]	67.71	N.A.	N.A.	44.23	11.13
19	1979[c]	67.71	N.A.	N.A.	46.80	5.81

Source : (a) Mehta, P.V. "Plywood Industry in India" 1974.
(b) DGTD office records.
(c) Composite Wood Branch, F.R.I.

Note : Production since 1970 onwards relates to D.G.T.D. units only; Small Scale Units having investment in plant and equipments of less than Rs. 7.5 lakhs were transferred to the respective State Directorates of Industries.

decoration), aircrafts manufacture, furniture and fixture industry, railway coaches (interior decoration), bus bodies, cabinets of radio and television, display boards in exhibition, sports goods, musical instruments, sewing and knitting machines industry etc.

The plywood is being manufactured under both the large scale and small scale sectors. While large scale units are producing mainly commercial plywood, 80% production in small scale units is tea-chest plywood.

The industry units are located in Assam, Kerala, Karnataka, Maharashtra, Andamans, West Bengal, Arunachal Pradesh, Nagaland, Andhra Pradesh and Uttar Pradesh.

Export of Plywood

The export of plywood including wood faced with veneer sheets which was of the order of 53 m^3 (valued at Rs. 11,400 thousands) in 1961–62 abruptly increased to 9,893 m^3 (valued at Rs. 13,080 thousands) in 1970–71 i.e. about 200 times during a short period of 9 years. It further increased to 33,286 m^3 (valued at Rs 82,175 thousands) in the year 1976–77. The export in 1977–78 and 1978–79 remained about 13,000 m^3 valued at Rs. 40 to 45 lakh only possibly due to supply of cheaper plywood from other countries. Table 2 gives the trend of plywood export from 1961–62 to 1978–79.

Direction Export

The plywood (decorative plywood, plastic laminated plywood and hollow or cellular wood panels) is being exported to Iraq, Kuwait, U.K., Nepal, Abudhabi, Dubai, Netherland, Tanzania, U.S.A. etc., of which the Iraq takes major share. The unit price (Rupees thousand per m^3) fetched in Iraq always remained greater than other countries.

The plywood industry has great export potential. As already recommended by N.C.A. 1976 that the export to Iraq etc., the middle east nations has been boosted up and the markets in West Asia and North African countries cultivated. Table 3 shows the direction of export and unit price (Rupees in thousands per m^3) obtained in the respective countries.

Forest Production & Export of Plywood

The time series data as given in Table 1 upto 1969 includes the production in small scale units while after 1970 the production related to D.G.T.D. units only. The use of time series data from 1961 to 1969 has not therefore been considered for present study. The data from 1970 onward has only been analysed for forecasting future production on the basis of growing apparent domestic consumption and the recommendation of the N.C.A. 1976 that the production should be double the domestic requirement by 1985.

The time series data from the year 1970–71 to 1978–79 has been studied through the common type of monotonic trend of plywood consumption i.e. exponential growth. A compound growth rate of apparent consumption of 6.14% per annum has been estimated over the period from 1970–71 to 1978–79 (Table 4a) following exponential growth function $Y_t = PX^t$; where (X–1) is compound growth rate of domestic apparent consumption of

Table

Export of Plywood including

Year	Decorative Plywood		Plastic laminated Plywood		Other Plywood	
	Q	V	Q	V	Q	V
1	2	3	4	5	6	7
1961-62	—	—	—	—	53	184
1962-63	—	—	—	—	266	267
1963-64	—	—	—	—	372	440
1964-65	—	—	—	—	428	654
1965-66	206	112	—	—	22	96
1966-67	70	58	—	—	429	666
1967-68	45	86	—	—	449	650
1968-69	714	1050	—	—	768	1387
1969-70	2405	3913	49	73	2590	2747
1970-71	3271	5993	152	124	6384	6884
1971-72	2019	4506	116	285	4058	5100
1972-73	1860	3830	27	60	2811	4525
1973-74	7307	13430	640	1402	14225	23495
1974-75	5614	15673	292	717	22351	48109
1975-76	5421	15242	20	95	9683	22075
1976-77	6310	16238	48	141	26895	65527
1977-78	3565	14173	341	1089	8061	27241
1978-79	2597	10487	69	449	4183	12367

2

wood faced with Veneer Sheets

Q = Quantity in m^3
V = Value in '000 Rupees

Hollow or cellular wood panels		Total		% rate of change over the preceding year	
Q	V	Q	V	Q	V
8	9	10	11	12	13
—	—	53	114	—	—
—	—	266	267	401.8	134.2
—	—	372	440	39.8	64.8
—	—	428	654	15.0	48.6
6	10	234	218	—45.3	—66.6
NA	NA	499	726	113.2	233.0
8	34	502	770	0.6	6.0
NA	NA	1482	2437	195.2	216.5
Neg.	1	5044	6734	240.3	176.3
86	79	9893	13080	96.1	94.2
2	15	6195	9906	—37.3	—24.2
5	19	4703	8434	—24.1	—14.8
331	833	22503	39161	378.4	364.3
465	1003	28722	65502	27.6	67.2
8	43	15132	37455	—47.3	—42.8
33	269	33286	82175	119.9	119.4
930	2216	12897	44719	—61.2	—45.6
6122	16746	12971	40049	0.6	—10.4

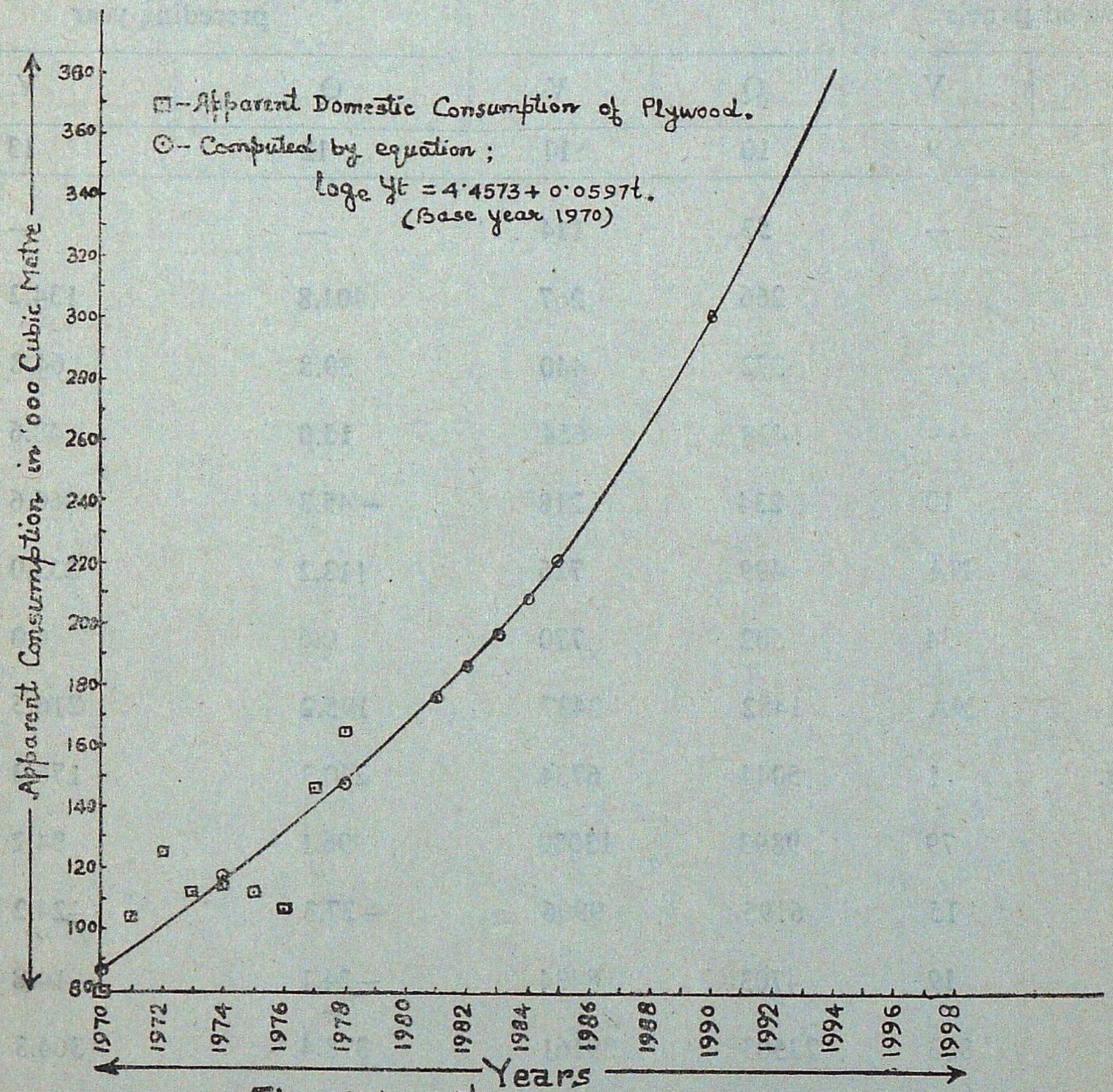


Fig.—Apparent Consumption Growth Curve.

plywood, Y_t —Apparent domestic consumption at time t. This on natural logarithmic scale becomes $\log Y_t = \log P + \log X.t.$ This method has been used for forecasting future domestic consumption of plywood. The parameters log P and log Y have been estimated by ordinary least square method and the equation becomes $\log_e Y_t = 4.4573 + 0.0597$ t. (see figure—Apparent consumption growth curve). By a conservative estimate if the same trend of consumption of plywood follows till 1985 and the target of export of atleast an equal quantity of plywood (that would be consumed in 1985) is to be achieved, the export in the year 1981, 1982 and 1984 may be safely assumed to be 25%, 40%, 60% and 80% respectively of domestic consumption. To meet this requirement the installed capacity of D.G.T.D. units with 90% capacity utilization should be 4,96,000 m³ in 1985.

The production, Export and Apparent consumption of plywood from 1970–71 to 1978–79 are given in Table 4a and projections from 1981 to 1985 are given in Table 4b.

Table 4a

The Production, Export and Apparent Consumption of Plywood

Sl. No.	Year	Production 000 m³	Export 000 m³	Apparent consumption 000 m³
1	1970–71	90.92	9.89 (10.87)	80.03 or 80.00
2	1971–72	110.16	6.19 (5.621)	103.97 or 104.00
3	1972–73	130.32	4.70 (3.61)	125.62 or 126.00
4	1973–74	134.52	22.50 (16.73)	112.02 or 112.00
5	1974–75	142.56	28.72 (20.15)	113.84 or 114.00
6	1975–76	127.00	15.13 (11.91)	111.87 or 112.00
7	1976–77	141.00	33.29 (23.61)	107.71 or 108.00
8	1977–78	159.20	12.90 (8.10)	146.30 or 146.00
9	1978–79	176.92	12 97 (7.33)	163.94 or 164.00

Note : Figures within parenthesis are the percentage of export over production.

Table 3

Plywood including wood faced with Veneer Sheets—Destinationwise Export of
(Decorative Plywood, Plastic Laminated Plywood and Hollow or Cellular Wood Panels)

Years	Name of the Countries to whom product exported														
	Iraq			Kuwait			U.K.			Nepal			Abu Dhabi		
	Q	V	UP	Q	V	UP	Q	V	UP	Q	V	UP	Q	V	UP
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1967-68	—	—	—	65	48	0.738	152	120	0.789	195	339	1.738	—	—	—
1968-69	17	35	2.059	353	559	1.583	186	208	1.118	179	594	3.318	—	—	—
1969-70	1275	2493	1.955	611	657	1.075	522	771	1.477	122	327	2.680	—	—	—
1970-71	2259	4679	2.071	309	52	0.168	231	370	1.602	460	621	1.350	—	—	—
1971-72	2419	5540	2.290	—	—	—	11	18	1.636	Neg	1	—	—	—	—
1972-73	2113	4594	2.174	—	—	—	46	178	3.869	497	783	1.575	—	—	—
1973-74	9924	19409	1.956	2770	3864	1.395	1480	2615	1.767	145	203	1.400	—	—	—
1974-75	18780	42958	2.287	584	1195	2.046	804	1389	1.728	460	779	1.693	—	—	—
1975-76	4261	14399	3.379	173	513	2.965	476	785	1.649	660	1613	2.444	1340	2328	1.737
1976-77	3131	13305	4.313	1599	3083	1.928	405	1197	2.955	489	1549	3.168	2074	4766	2.298
1977-78	4709	22053	4.683	48	236	4.916	122	361	2.959	406	1565	3.855	—	—	—
1978-79	1530	7131	4.661	18	82	4.555	113	784	6.938	878	3498	3.948	—	—	—

(Contd column 17–31)

Q = Quantity Exported in m^3
V = Value in thousand Rupees.
UP = Unit Price (in thousand Rupees per m^3)

Name of the countries to whom product exported														
Dubai			Muscat			Qatar			Other Countries			TOTAL		
Q	V	UP	Q	V	UP	Q	V	UP	Q	V	UP	Q	V	UP
17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
—	—	—	—	—	—	—	—	—	89	263	2.955	502	771	1.536
—	—	—	—	—	—	—	—	—	747	1041	1.393	1481	2437	1 645
—	—	—	—	—	—	—	—	—	2519	2486	0.987	5045	6734	1.335
—	—	—	—	—	—	—	—	—	6634	7358	1.109	9894	13080	1.322
—	—	—	—	—	—	—	—	—	3765	4347	1.154	6195	9906	1.599
—	—	—	—	—	—	—	—	—	2047	2879	1.406	4703	8434	1.793
—	—	—	—	—	—	—	—	—	8185	13070	1.597	22504	39161	1.740
—	—	—	—	—	—	—	—	—	8093	19181	2 370	28721	65502	2.281
2997	5286	1.764	1253	2479	1.978	515	1374	2.668	3457	8679	2.510	15132	37456	2.475
9663	21147	2.188	—	—	—	989	2573	2.602	14936	34355	2.300	33286	82175	2 469
—	—	—	—	—	—	457	1274	2.788	7155	19230	2.687	12897	44719	3 467
—	—	—	—	—	—	315	834	2.648	10117	27720	2.740	12971	40049	3.087

Table 4b

Porjection for Apparent Consumption, Export & Total Production in 1985

Year	Apparent consumption 000 m^3	Export 000 m^3	Total production 000 m^3	Wood requirement 000 m^3 (60% recovery)	Installed capacity 000 m^3 at 90% capacity utilization
1981	176	44 (25%)	220	367	271
1982	187	75 (40%)	262	437	291
1983	198	119 (60%)	317	528	352
1984	210	168 (80%)	378	630	420
1985	223	223 (100%)	446	743	496

Note : Figures within parenthesis are the percentage of export over consumption.

The N C.A. 1976 has estimated population during 1985 as 724.91 million. Thus the consumption per thousand capita would be 0.31 m^3 in 1985.

Prospect of Availability of additional ply logs

The supply and cost of raw materials are key guiding factors for promotion of an industry. For plywood industry, the basic raw material is timber and glue. They together share more than 65% production cost. The wood itself shares 45% to 50% of total production cost conclusively is a major input. This key input is becoming scarce. It is becoming a serious constraint for achieving even the current level of production. The situation may be eased by increasing the recovery of plywood and utilising veneer logs hither to exported. The recovery of plywood from ply logs input (with bark) has been estimated (Pant, 1974), to be about 60% which is further influenced by factors such as : (a) physical condition of the log (presence of buttresses, any kind of decay, crotches, brash wood, knots, cracks, split and taper etc., reduces outturn considerably), (b) machinery available for processing and (c) supervision during processing. The timber losses occur during various operations such as debarking of the log, rounding, ends scoring (spurtrim), core (left over roller), clipping, shrinkage of veneers in drying, jointing, compression and pressing and trimming of plywood sheets and resizing. The wood losses such as spurtrim, core (left over roller), jointing veneers and trimming and resizing of plywood sheet are about 20% can definitely be minimised by using improved machinery.

The export of saw logs and veneer logs from India has been estimated (FAO, 1979) around 36,000 m^3 per annum (average of 1973 to 1977), and was resulting in loss of employment and scarcity of raw material in timber processing industries. The Govt. of India after all banned export of all species of wood and timber. in log and sawn forms since 28.5.1980 (Hindustan Times, New Delhi, dated 25.5.80). This pragmatic approach will make more ply

logs available to plywood industry. With a very conservative estimate even if only 60% of this now available veneer logs goes to plywood industry, there will be an additional production of about 13,000 m^3 plywood every year which is equivalent to total export of plywood (plywood including wood faced with veneers) during 1978–79.

Conclusion

The export of plywood has never been static although it touched its highest about 24% of total production during 1976–77. The Sixth Five Year Plan placed high priority to export of finished products which will work as incentive to increase production making full use of available raw material. The present study has focussed the attention of exporters and producers to achieve the target of 1985 by exporting quality material adhering the delivery schedules and increasing prodcution by utilizing varying range of species, and adopting improved technology. The incentives such as relaxation in excise duty, providing glue at international prices etc, are required for boosting the investment to achieve the estimated installed capacity by 1985. The requirement of raw material (timber) in 1985 is likely to be 74 thousand m^3 and efforts should be accelerated by Forest Departments to meet the challenge.

Acknowledgements

The authors are thankful to Dr. K.R. Satyamurthi, Officer-in-Charge, Statistical Branch and Shri L.P. Chandola, Research Officer, Forest Economics Branch, for their help in computation work and to Shri M.K. Lala, Officer-in-Charge, Composite Wood Branch, for providing valuable information. Thanks are also due to Shri Kundal Lal Batra, Stenographer for his valuable help.

SUMMARY

The Sixth Five Year Plan placed high priority to export with a target of 5.2 per cent annual growth in gross domestic product. The role of the export in improving the balance of payments and as incentive to increase the production need no emphasis. The plywood industry has definite role to play to meet the challenge of Export front. The plywood export has emerged on export map of the World in 1961-62. The quantity exported in various years, fluctuated year to year with many minima and maxima. The possible reasons attributed to such fluctuation are : (a) increased production cost due to short supply of ply logs of rigid specifications; price of the glue many times more than international price and antiquated machinery; (b) quality of the plywood and (c) non-adherence to delivery schedules. The report of the National Commission on Agriculture 1976 (Part IX Forestry) Govt. of India has prescribed certain measures such as to make available glue at international prices, to update the technology for reducing the losses and sophisticated machinery to produce quality veneers and to raise the export equal to domestic consumption by 1985.

The plywood industry has great export potential as is evident from the fact that the share of plywood export to the total foreign trade in major forest produce during 1974-75 was 27.80 per cent. The present study has been taken up to forecast the domestic consumption, rate of growth of export, total production of plywood and necessary requirement of wood and installed capacity for the period 1981 to 1985.

भारत में स्तरकाष्ठ उद्योग और इसकी नियति संभावनाएं

लेखक एस०आर० सागर व एम०वाई० अन्सारी

सारांश

छठी पंचवर्षीय योजना में सकल घरेलू उत्पादों में 5.2 प्रतिशत वार्षिक वृद्धि करने का लक्ष्य निर्धारित करके उनके निर्यात को अत्यधिक प्राथमिकता दी गई है। भुगतान के संतुलन को सुधारने तथा उत्पादन बढ़ाने में प्रोत्साहन देने में निर्यात की भूमिका वताने पर विशेष बल देने की जरूरत नहीं है। निर्यात मोर्चे पर मिली चुनौती का सामना करने में स्तरकाष्ठ उद्योग को अपनी निश्चित भूमिका निबाहनी है। स्तरकाष्ठ निर्यात का उदय विश्व के निर्यात मानचित्र में 1961-62 में हुआ। विगत वर्षों में निर्यात की गई मात्राएं वर्ष प्रतिवर्ष घटती-बढ़ती रही और उनके न्यूनतम और अधिकतम भी अनेक रहे। इस प्रकार हुई घट बढ़ों को निम्न कारणों से जोड़ा जा सकता है (क) ठीक-ठीक विशिष्टयों वाले स्तरकाष्ठ लट्ठों का प्रदाय कम रहने से उत्पादन लागत में वृद्धि, अभिलागी का दाम अन्तर्राष्ट्रीय कीमत के मुकाबले में कई गुना अधिक होना और मशीनरी का पुरानापन, (ख) स्तरकाष्ठ की गुणवत्ता, (ग) सामान पहुंचाने की तालिकाओं का पालन न किया जाना। भारत सरकार के राष्ट्रीय कृषि आयोग की रिपोर्ट, 1976, (भाग 9 वानिकी) में अन्तर्राष्ट्रीय मूल्यों पर अभिलागी उपलब्ध करना, हानि कम करने के लिए प्रौद्योगिकी को अद्यतन बनाना, उत्तमकोटि की परतें बनाने के लिए बढ़िया किस्म की मशीनरी लगाना तथा 1985 तक निर्यात को घरेलू उपभोग की बराबरी तक ले जाना जैसे कुछ उपाय सुझाऐ गए हैं।

स्तरकाष्ठ उद्योग की निर्यात संभावनाएं बहुत हैं जैसा कि इसी तथ्य से स्पष्ट है कि 1974-75 में मुख्य वनोत्पादों के कुल विदेशी व्यापार में स्तरकाष्ठ निर्यात का अंश 27.80 प्रतिशत था। वर्तमान अध्ययन इसके घरेलू उपभोग, निर्यात वृद्धि की दर, स्तरकाष्ठ का कुल उत्पादन तथा 1981 से 1985 तक की अवधि में लकड़ी की अपेक्षित आवश्यकता और स्थापित क्षमता का पूर्वानुमान प्रस्तुत करने के लिए किया गया है।

References

Anon. (1976). Report of the National Commission on Agriculture Part IX Forestry, Govt. of India, Ministry of Agriculture and Irrigation, New Delhi.

Anon. (1964). IS : 656 Specification for logs for Plywood.

Anon. (1964). IS : 10 Specification for Plywood Tea-chest.

Anon. (1979). F.A.O., *Yearbook of Forest Products*.

Anon. (1980). *Eastern Economist*, 75 (21) 1158–1159.

Anon. (1961-79) Monthly Statistics of the Foreign Trade of India, Vol. I (3) 1961–62 to 1978–79), Govt. of India, Department of Commercial Intelligence & Statistics, Calcutta.

Carl F. Crist (1970). *Econometric Models and Methods*. Wiley Eastern Pvt. Ltd., New Delhi.

Mehta, P. V. (1974). Plywood Industry in India.

Nagaraju, S. etc. (1974) Green Veneer yield in Rotary Cutting. *IPRI J.* 4 (4), 141–151.

Pant, H. C. (1974). Recovery of Timber under ideal conditions of Plywood Manufacture *IPIRI J.* 4 (4), 152–154.

— ——— —

EFFECT OF N, P, K FERTILIZER APPLICATIONS ON GROWTH OF *PINUS CARIBAEA* SEEDLINGS

D.C. AGRAWAL*, S.K. RAWAL AND H.P. BHATNAGAR

Plant Physiology Branch,
Forest Research Institute & Colleges, Dehra Dun

Introduction

Use of fertilizers in forestry especially in nurseries and early stages of raising plantation has become a regular silvicultural practice in many countries (White and Leaf, 1956; Stoeckler and Arneman, 1960; Mustanoja and Leaf, 1965). Now it is well recognised that forest nursery stock makes a considerable drain on soil nutrients which has to be replenished by appropriate use of fertilizers for sustenance of nursery growth and also to restore soil fertility. Schaedle, 1959; Smith and Allen, 1962; Van Den Driessche, 1963; Thor, 1965; and Walter *et al.*, 1961 have illustrated in detail the importance of using chemical fertilizers to improve the quality of nursery stock for planting. *Pinus caribaea* Morelet var. *hondurensis* an exotic pine, introduced recently in India was selected for the present fertilizer trials as no systematic investigation has so far been carried out in India.

Material and Methods

Top 20–25 cm soil from *Pinus roxburghii* plantation of the Demonstration Area, Forest Research Institute, Dehra Dun was collected, air dried, screened through 1 cm mesh and soil and river sand mixture (3 : 1) was filled into experimental pots Physical and chemical characteristics of soil were as follows :

Physical

Sand%	Silt%	Clay%	Texture
60.3062	31.3388	0.3550	Silty loam

Chemical

pH	Total N %	Available P %	Exch. K m.e. %	Exch. Ca m e. %	Exch. Mg m.e. %	C.E.C. m.e. %	Carbon %	Organic matter %
6.8	0.147	0.0275	0.36	4 6	2.2	10.9	1.82	3 17

* Presently Scientists, National Chemical Laboratory, Pune.

Four month old seedlings of *Pinus caribaea* of uniform height and vigour were established in soil cultures and given urea, superphosphate and muriate of potash as respective N, P, K sources at 112, 224, 336 kg/ha on nutrient basis and in different possible combinations as per factorial design.

These 3×3×3 i e., twenty seven combinations of doses were given in two equal split applications. First half of fertilizer dose was applied after 15 days of transplanting of *P. caribaea* seedlings in pots and remaining half dose was applied after three months of first application. Experiment was continued for 12 months. At the end of this period the seedlings were evaluated for height and diameter growth and then removed from soil cultures, washed, sponged dry and weighed for fresh weight determination. The seedlings were then oven dried at 60°C for 24 hours and dry weight recorded.

Results and Discussion

(a) *Height and diameter growth*

Maximum absolute height increment of 41.54 cm was recorded for seedlings growth as N_3 P_1 K_3 nutrient levels, i.e., nitrogen, phosphorus and potassium at 336, 112, 336 kg ha. Minimum absolute height of 18.10 cm was registered for control seedlings growing without any fertilizer application. Keeping phosphorus (P) and Potassium (K) level at 112 kg/ha i.e., P_1 K_1 and increase of nitrogen level from 112 through 224 to 336 kg/ha i e., N_1 to N_3, there was linear increase in absolute height increment at N_1, N_2 and N_3. The values were 21.13, 25.69 and 28.58 cm respectively. Similar trend of linear increment was followed by absolute diameter. Respective values for absolute diameter increment at N_1, N_2 and N_3 levels of nitrogen fertilizer were 2.99, 3.47, 3.62 mm (Table 1, Treatment 2–4).

Keeping phosphorus (P) level at 112 kg/ha and potassium (K) level at 224 kg/ha i.e., P_1 K_2 and increasing nitrogen from N_1 to N_3 level i.e., 112 to 336 kg/ha there was an increase in absolute height and absolute diameter. The values for absolute height increment at N_1, N_2 and N_3 level of nitrogen fertilizer application were 22.87, 26.12, 28.30 cm and for absolute diameter increment at 3.20, 3.45 and 3.73 mm respectively (Table 1, Treatment 5–7).

Increase of potassium (K) level to 336 kg/ha at a constant phosphorus level of 12 kg/ha exhibited considerable increase in absolute height with increasing nitrogen fertilizer application from 112 kg through 224 to 336 kg/ha. The respective height increment at N_1. N_2 and N_3 level was 24.80, 38.32 and 41.54 cm. However, marginal increment in absolute diameter was exhibited when nitrogen was increased from N_1 to N_2 level i.e., 112 kg to 224 kg/ha. While, at N_3 level it was substantial. The respective values for absolute diameter increment at N_1, N_2 and N_3 levels were 3.46, 3.54 and 4.51 mm (Table 1, Treatment 8–10).

Table 1

Effect of N, P, K fertilizer application on absolute height (cm), diameter increment (mm) and fresh weight and dry weight (gm) in seedlings of Pinus caribaea

Treatment No.	Treatment Code	Absolute height increment (cm)	Absolute diameter increment (cm)	Fresh weight (gm)	Dry weight (gm)
1	$N_0 P_0 K_0$	18.10	2.50	22.65	5.03
2	$N_1 P_1 K_1$	21.13	2.99	25 01	5.94
3	$N_2 P_1 K_1$	25.69	3.47	26.13	5.95
4	$N_3 P_1 K_1$	28.58	3.62	29.83	6.51
5	$N_1 P_1 K_2$	22.87	3.20	25.42	6.27
6	$N_2 P_1 K_2$	26.12	3.45	28.03	6 40
7	$N_3 P_1 K_2$	28.30	3.73	30.72	6.59
8	$N_1 P_1 K_3$	24.80	3.46	25 87	6 50
9	$N_2 P_1 K_3$	38.32	3 45	30.00	7.08
10	$N_3 P_1 K_3$	41.54	4.51	32.78	8.09
11	$N_1 P_2 K_1$	21.10	2.85	22.15	5 13
12	$N_2 P_2 K_1$	20.10	2.93	23.24	5.39
13	$N_3 P_2 K_1$	22.33	3.03	22.66	5.29
14	$N_1 P_2 K_2$	22.53	2.95	20.87	4.96
15	$N_2 P_2 K_2$	31.08	3 07	21.59	4.94
16	$N_3 P_2 K_2$	32 44	3.09	23.41	5.22
17	$N_1 P_2 K_3$	25.97	3.11	23 02	5.19
18	$N_2 P_2 K_3$	29.03	3.35	22.06	4.53
19	$N_3 P_2 K_3$	33.14	4.14	24.18	5.36
20	$N_1 P_3 K_1$	21.94	2.95	26 02	5.72
21	$N_2 P_3 K_1$	24.34	3.13	26.36	5.78
22	$N_2 P_3 K_1$	27 42	2.99	24.18	6.23
23	$N_1 P_3 K_2$	23.13	3.25	26.17	5.64
24	$N_2 P_3 K_2$	26 53	3.15	27.75	6.24
25	$N_3 P_3 K_2$	28.71	3 61	28.95	6.56
26	$N_1 P_3 K_3$	27.78	3.61	22.33	4.71
27	$N_2 P_3 K_3$	28.89	3.66	22.20	4.75
28	$N_3 P_3 K_3$	26.35	3.85	22.92	5.07

At fixed level of phosphorus (P) and potassium (K) combination at 224 kg and 112 kg/ha and varying nitrogen (N) nutrient level from 112 to 336 kg/ha, the maximum absolute height increment was exhibited at N_3 level followed at N_1 and N_2 by seedlings of *P. caribaea*. Respective height increment at N_1, N_2 and N_3 levels of nitrogen fertilizer was 21.10, 20.10, 22.33 cm. On the centrary a linear increment was recorded for daimeter increment with the increase of nitrogen application, corresponding diameter increment in seedligns was 2.85, 2.93 and 3.03 mm (Table 1, Treatments 11–13).

Phosphorus (P) and potassium (K) each at 224 kg/ha nutrient application and increasing nitrogen application from 112 kg through 224 kg to 336 kg/ha, the height at N_1 was very poor showing increment of only 22.53 cm. This considerably increased at N_2 (31 08 cm) level while, further increase of nitrogen nutrient to N_3 level contributed only marginal increment in height (32.44 cm). On the other hand absolute diameter exhibited linear increment with increase of nitrogen, but it was marginal. Absolute diameter at N_1, N_2 and N_3 levels was 2.95, 3.07, 3.09 mm respectively. (Table 1, Treatments 14–16).

At 224 kg and 336 kg/ha of phosphorus (P) and potassium (K) nutrient application respectively, increase of nitrogen nutrient from N_1 to N_3 level exhibited linear increase in both absolute height and diameter. Respective values for height at N_1, N_2 and N_3 were 25 97, 29 03 and 33.14 cm and for diameter 3.11, 3.35 and 4.14 (Table 1, Treatment 17-19).

Increasing phosphorus to 336 kg/ha and keeping potassium at 112 kg/ha, there was increase in height with increase of nitrogen nutrient from N_1 to N_3 level. Respective height at N_1, N_2 and N_3 levels was 21.94, 24.34 and 27.42 cm. However, maximum absolute diameter (3.13 mm) was obtained at N_2 level followed by N_1 and N_3 giving 2.95 and .99 mm increment. (Table 1, Treatments 20–22).

At P_3 K_2 nutrient applications i e., phosphorus at 336 kg/ha and potassium at 224 kg/ha, increase of nitrogen from N_1 to N_3 level exhibited increase in absolute height increment, however, reverse was true for absolute diameter which showed decreasing trend with increasing nitrogen application. Respective values for height increment at N_1, N_2 and N_3 nutrient application were 23.13, 26.53 and 28.71 cm and for diameter increment these were 3.25, 3.15 and 3.61 mm (Table 1, Treatments 23–25).

Application of maximum doses of phosphorus (P_3) and potassium (K_3) and increasing amounts of nitrogen nutrient from 112 kg/ha through 224 kg to 336 kg/ha, maximum height increment of 28.89 cm was recorded at N_2 level followed by N_1 and N_3 levels (27.78, 26.35 cm). This clearly indicates that application of all the three nutrients at maximum levels i e., each at 336 kg/ha inhibits height growth for seedlings of *P. caribaea*. On the other hand, absolute diameter increased linearly with increasing nitrogen fertilizer

application. Although increment of these levels was not substantial. The respective values for diameter increment at N_1, N_2 and N_3 levels were 3.61, 3.66 and 3.85 mm (Table 1, Treatments 26–28).

(b) *Fresh and dry weight*

Taking phosphorus and potassium at fixed combination of P_1 K_1 i.e., each at 112 kg/ha of nutrient application and varying nitrogen level from 112 kg/ha through 224 kg to 336 kg/ha there was linear increment of fresh weight of entire seedling of *P. caribaea*. Respective fresh weight at N_1, N_2 and N_3 level was 25.01, 26.13 and 29.83 gm. Similar trend was exhibited by dry weight, although increment at N_1 to N_2 level was not substantial. Dry weight recorded at N_1, N_2 and N_3 levels was 5.94, 5.95 and 6.51 gm (Table 1, Treatment 2–4).

At fixed phosphorus (P_1) and potassium (K_2) level i.e., P_1 K_2 combination, with increasing nitrogen nutrient from 112 kg through 224 kg to 336 kg/ha there was concomitant increase in total plant fresh weight (25.42, 28.03 and 30.72 gm respectively). Dry weight for entire plant also followed the similar pattern (6.27, 6.40 and 6.59 gm respectively. (Table 1, Treatment 5–7).

On increasing potassium to K_3 level i.e., 336 kg/ha and maintaining phosphorus at P_1 level, the increase in nitrogen supply from N_1 to N_3 level increased fresh and dry weight of entire seedling of *P. caribaea*. Respective fresh weight values at N_1, N_2 and N_3 levels of nitrogen nutrient were 25.87, 30 00 and 32.78 gm and corresponding dry matter accumulation was 6.50, 7 08 and 8.09 gm. (Table 1, Treatments 8–10).

On increasing the phosphorus level to 224 kg/ha with potassium at 112 kg/ha maximum fresh and dry weight for entire seedling of *P. caribaea* were obtained at N_2 level (23.24 and 5 39 gm respectively). Nitrogen at N_1 and N_3 levels resulted 22.15, 22.66 gm of fresh weight while corresponding dry weight values were 5.13 and 5.29 gm. This makes amply clear that higher level of nitrogen fertilizer was inhibitory for fresh and dry matter accumulation (Table 1, Treatments 11–13).

Keeping phosphorus and potassium fixed at 224 kg/ha nutrient application and increasing nitrogen nutrient supply from 112 kg to 336 kg/ha there was linear increase in fresh weight production by entire seedling of *P. caribaea*. The respective values for each fresh weight at N_1, N_2 and N_3 were 20.87, 21 59 and 23.41 gm. However, for dry matter accumulation there was not much significant difference at N_1 and N_2 level (4 96, 4.94 gm). Maximum dry matter production was recorded at N_3 level of nitrogen nutrient fertilizer application (Table 1, Treatments 14–16).

On further increase in potassium supply to 336 kg/ha and maintaining phosphorus supply at 224 kg/ha, maximum fresh weight of 24.18 gm was recorded at 336 kg/ha of nitrogen supply followed by 112 kg and 224 kg/ha. The respective values at these two

levels were 23.02 and 22.06 gm. Similar trend was exhibited by dry matter accumulation. Corresponding dry weight of N_1, N_2 aud N_3 was 5.19, 4.53 and 5.36 gm (Table 1, Treatments 17–19).

With maximum phosphorus (P_3) and minimum potassium (K_1) nutrient supply fresh weight increased with increasing nitrogen supply from N_1 to N_2 level (26 02, 26.36 gm), while at N_3 level there was depression in fresh weight (24.18 gm). On the other hand dry matter production for total seedling of *P. caribaea* increased linearly with increasing nitrogen fertilizer supply. The respective dry weight at N_1, N_2 and N_3 was 5.72, 5.78 and 6.23 gm (Table 1, Treatment 20–22).

At fixed P_3 K_2 supply i.e., phosphorus 336 kg and potassium 224 kg/ha and increase in nitrogen from 112 kg through 224 kg to 336 kg/ha fresh and dry weight also increased linearly. Respective fresh weight at N_1, N_2 and N_3 was 26.17, 27.75 and 28.95 gm and corresponding dry matter accumulation was 5.64, 6.24 and 6.56 gm. (Table 1, Treatments 23–25).

At 336 kg/ha application of phosphorus (P_3) and potassium (K_3) increase of nitrogen supply from N_1–N_3, maximum fresh weight of 22 92 gm was recorded at N_3 level followed by N_1 (22.33 gm) and N_2 (22.20 gm) nitrogen nutrient level. However, increase in dry weight was linear with increasing nitrogen supply. The respective dry matter accumulation at N_1, N_2 and N_3 was 4.71, 4.75 and 5.07 gm. (Table 1, Treatments 26–28).

Control *P. caribaea* seedlings to which no fertilizer dose was applied (N_0 P_0 K_0) exhibited fresh and dry weight of 22.65 and 5.03 respectively. (Table 1, Treatment 1).

(c) *Morphology*

Seedlings of *P. caribaea* growing under different N,P,K fertilizer treatments (27 in all as factorial combinations given earlier), survived for the entire period of investigation. Seedlings growing at the optimum supply of nitrogen, phosphorus and potassium, i.e., N_3 P_1 K_3 exhibited luxuriant growth. Plants were green with no visible deficiency symptom.

P. caribaea seedlings growing without any fertilizer treatment showed poorest shoot growth. Secondary needles were a few, short and primary needles poorly developed. Stem was linear in height with no lateral branching. Needle tips were drying.

Application of maximum amount of all the three N, P, K fertilizers i.e., each at 336 kg/ha of nutrient exhibited poor shoot development in comparison to nutrient levels applied at N_3 P_1 K_3. It makes amply clear that increasing phosphorus application from 112 kg/ha to 336 kg/ha was deleterious to shoot growth, there were many lateral branches through out the stem. Secondary needles were long, spreading. Lateral branches in the lower half of stem were young. Over all height growth was restricted.

Lowest dose of N, P, K fertilizers i.e., each at 112 kg/ha of nutrient also showed poor growth than the seedling growing at optimum levels i.e , $N_3 P_1 K_3$. However, the plants were comparatively better than under the $N_3 P_3 K_3$ dose. Lateral branches restricted to lower half of stem were well developed. Secondary needles were long, spreading. Plants were better in height and diameter growth than controls and under $N_3 P_3 K_3$ treatment.

Results obtained for height and diameter growth clearly indicate that application of $N_3 P_1 K_3$ composition of fertilizers i.e., urea, superphosphate and muriate of potash at 336 kg/ha, 112 kg/ha and 336 kg/ha of respective N, P, K nutrients is the optimum dose for growth of *Pinus caribaea* var. *hondurensis* seedlings in conditions of chir pine forest soil of demonstration area, New Forest, Dehra Dun (Table 1, Treatment 10).

Results of fresh weight and dry weight of entire seedlings or total plant and shoat morphology also support the supremacy of $N_3 P_1 K_3$ composition over all other fertilizer combinations (Table 1, Treatment 10).

From the foregoing discussion, it is evident that soil of chir pine forest being utilised for raising of *Pinus caribaea* seedlings at tropical pine nursery of Forest Research Institute, Dehra Dun is sub-optimal in N, P, K nutrient supply as far as this species is concerned. Therefore, supply of N. P, K nutrients at 336 kg, 112 and 336 kg/ha in soil is necessary for optimum growth of seedlings of this species.

Acknowledgements

The author (D.C.A.) is thankful to the President, Forest Research Institute and College, Dehra Dun for providing post M.Sc. Research Fellowship during the tenure of present investigations.

SUMMARY

Using a statistically laid 3^3 factorial design, the optimum N, P and K requirement for the growth of *P. caribaea* seedlings was determined under Glass House conditions Four month old *Pinus caribaea* seedlings were grown in soil cultures and provided with urea (nitrogen source), superphosphate (phosphorus source), and muriate of potash (potassium source) Nitrogen at 336 kg/ha, phosphorus at 112 kg/ha and potassium at 336 kg/ha were the optimum N, P and K requirements to produce maximum height and diameter growth and biomass production. Since the soil used for experimentation was taken from the chir pine forest of Forest Research Institute, Dehra Dun, it is recommended that for the preparation of nursery beds for *Pinus caribaea* seedlings the soil should be supplemented with N, P and K levels as determined above.

पाइनस कैरिबिया के पौधों की वृद्धि पर नाइट्रोजन, फास्फोरस और पोटाश दिए जाने का प्रभाव

लेखक डी०सी० अग्रवाल, एस०के० रावत व एच०पी० भटनागर

सारांश

3 घनमीटर का सांख्यिकी सम्मत बनाया गया एकादिहत् अभिकल्प उपयोग में लाकर कांचघर दशाओं में पा० कैरिबिया के पौधों के लिए नाइट्रोजन, फास्फोरस और पोटाश की इष्टतम आवश्यकताएं विनिश्चित की गई हैं। चार मास के पाइनस कैरिबिया पौधे मृदा में उगाए गए तथा उनमें यूरिया (नाइट्रोजन स्रोत), सुपरफास्फेट (फास्फोरस स्रोत) और पोटाश म्यूरिएट (पोटाशियम स्रोत) की खाद दी गई। नाइट्रोजन 336 किग्रा०/हैक्टे०, फास्फोरस 112 किग्रा०/हैक्टे० और पोटाशियम 336 किग्रा०/हैक्टे० देना अधिकतम ऊंचाई व्यास वृद्धि और जैवपुंज उत्पादन लाने के लिए नाइट्रोजन, फास्फोरस, और पोटाशियम की इष्टतम आवश्यकताएं रही। चूंकि इस प्रयोग के लिए मृदा वन अनुसंधान संस्थान, देहरादून के चीड़ वन से ली गई थी इसलिए यह अभिस्तावित किया जाता है कि पाइनस कैरिबिया के पौधों की रोपणी में क्यारियां बनाने के लिए मिट्टी में ऊपर बताए अनुसार नाइट्रोजन, फास्फोरस और पोटाशियम भी दिया जाना चाहिए।

References

Mustanoja, K J. and Leaf, A.L. (1965). Forest Fertilization Research, 1957–1964, *Bot. Rev.* 307 : 151–246.

Schaedle, M. (1959) A study of the growth of Douglas fir *(Pseudotsuga menziesii)* seedlings Univ. of Br. Columbia, Fac. of Agri., *M.S.A. Thesis*, pp. 98.

Smith, J H.G. and Allen, G.S. (1962). Improvement of Douglas fir for planting stock. Univ. of Br. Columbia, Fac. of For., *Res. Paper* No. 55, pp. 16

Stoeckler, J.H. and Arneman, H.F. (1960). Fertilizers in Forestry. *Adv. Agron.* 12 : 127–195,

Thor, E. (1965). Effects of eight nursery treatments on yellow poplar seedlings characteristics and yield performance. *Tree Plrs Notes* 72 : 16–18.

Van Den Driessche, R (1963). Nursery experiments with Douglas fir. *Comm. For. Rev.* 42 (3) : 242–254.

Walters, J., Soos, J. and Haddock, P G. (1961). The influence of fertilizers on growth of Douglas fir seedlings in the University of British Columbia Research Forest, Haney. Univ. of Br. Columbia, Fac of For., *Res. Note* No. 31, pp. 6.

White, D.P. and Leaf, A.F. (1956) "Forest Fertilization". *Wld. For. Ser. Bull.* 2.

GERMINATION OF *POPULUS CILIATA* SEED AS INFLUENCED BY MOISTURE STRESS

R.V. SINGH AND VIRENDRA SINGH

Conifers Research Centre, Simla (Himachal Pradesh)

Introduction

Populus ciliata seed is normally dispersed in June with the onset of premonsoon showers in North-west Himalayas (Singh, 1981). The seed is shortlived and before germination it is subjected to alternate wetting and drying and consequent moisture stress. The effect of moisture stress on germination of *P. ciliata* seed is, however, not known and the present study was accordingly undertaken.

Materials and Methods

The experiment was conducted in June-July, 1980. *Populus ciliata* seed extracted on 20th June from the capsules collected on 14th June was used. Sowing was done on 21st June on filter paper in petri dishes in which the solution of polyethylene glycol (PEG) prepared according to the method given by Zur (1966) to create moisture stress of –0.5, –1.0, –1.5, –2.0, –2 5 and –3.0 atm was applied. In case of control ordinary water was applied in place of PEG solution. The above seven treatments were replicated four times. Fifty seeds were sown in each petri dish. Germination test was conducted in BOD incubator at 20°C. Germination counts were made daily after the commencement of germination. A seed was taken to have germinated when the hypocotyl had grown out of the seed coat just far enough to raise one side of the seed from the substrata (Sato, 1949). PEG solution and water, according to the treatment, were added at regular intervals to keep the filter paper moist.

Germination values were calculated following the method of Czabator (1962). Statistical analysis of the data of germination percentages was done after arc sine transformation.

Results and Discussion

Table 1 presents the germination percentage and germination value as affected by different levels of moisture stress.

Table 1

Germination of P. ciliata seed as affected by moisture stress

Moisture stress (Atm)	Germination Percentage	Germination Value
0	73.0	23.45
–0.5	69.0	15.64
–1.0	41.0	5.39
–1.5	26.5	2.21
–2 0	25.0	2.01
–2 5	10.0	0.72
–3.0	3.0	0 13

The germination percentage as well as the germination value decreased as the moisture stress increased. The moisture stress depressed both the germination percentage and the germination value significantly (1% level) except for –0.5 atm moisture stress in whose case the reduction in germination percentage as compared to control was not statistically significant.

The findings of this study are in agreement with those of Farmer and Bonner (1967) who reported that the germination energy of eastern cottonwood seed gradually decreased as the moisture stress increased from 0 to –10 atm; moisture stress of –15 atm inhibited the germination except at high germination temperatures. Reduction in germination at higher levels of moisture stress may possibly be attributed to the moisture deficit in the seeds below the threshold which may lead to degradation and inactivation of the essential hydrolytic and other groups of enzymes as suggested by Wilson (1971).

SUMMARY

Germination of *Populus ciliata* seed decreased as the moisture stress increased and the germination at a moisture stress of –3 atm was only negligible.

आर्द्रता दबाव से प्रभावित हुए पापुलस सिलियाटा बीजों में अंकुरण

लेखक आर० वी० सिंह व वीरेन्द्र सिंह

सारांश

आर्द्रता दबाव बढ़ाते जाने के साथ-साथ पापुलस सिलियाटा के बीजों का अंकुरण घटता चला गया और आर्द्रता दबाव–3 एटम हो जाने पर अंकुरण लगभग नगण्य रह गया ।

References

Czabator, Felix J. (1962). Germination value : an index combining speed and completeness of pine seed germination. *For. Sci.* **8** (4) : 386–396.

Farmer, R.E. Jr. and Bonner, F.T. (1967). Germination and initial growth of eastern cottonwood as influenced by moisture stress, temperature and storage. *Bot. Gaz.* **128** (3-4) : 211–215.

Sato, Hoshio (1949). On the viability of *Populus* seeds. Hokkaido Uni. Coll, Agric. Exp. Forests *Res. Bull.* **14** (2) : 97 Sapporo, Japan (c.f. For. Serv. *USDA Agric Handb.* No. 450. p. 651).

Singh, R.V. (1981). Silvics and ecology of *Populus ciliata* symposium Proceedings : Silviculture, Management and utilization of Poplars. Oct., 15–18, 1979., Srinagar. 62–66. The Controller of Publications, Delhi.

Wilson, A.M. (1971). Amylase synthesis and stability in crested wheat grass seeds at low water potentials. *Plant Physiol.* **48** : 541–546.

Zur, B. (1966). Osmotic control of the matric soil-water potential. I. Soil-water system. *Soil Sci.* **102** (6) : 394–398.

HAZARD REDUCTION FOR FOREST FIRE PREVENTION

P M. SANGAL*

Forest Fire Protection Research,

Forest Research Institute and Colleges, Dehra Dun

Introduction

'Hazard' is a measure of that part of fire danger which is dependent on the fuels available for burning and their relative amount, class, character, moisture content and condition. The term is also used for the inflammable material constituting a threat of either special suppression difficulty or likelihood of ignition because of its location (Anonymous, 1953, 1960). Though living vegetation will also burn in an on-going fire, it is the dead organic material consisting of fallen leaves, pine needles, bark chips, dead grass, twigs, branches, stumps, logs etc. in which the fire is likely to start and which constitutes the real fire hazard. The inflammability of such fuels denotes the susceptibility of ignition due to the presence and activity of an ignition cause. Thus, generally speaking wherever risk (presence and activity of ignition causes) and hazard (inflammable fuel) are present, a situation of fire danger exists. If either risk or hazard is absent, there will be no fire. However, in most forest areas both risk and hazard are present in varying degrees. For effective fire prevention, reduction of hazard is, therefore, as important as reduction of risk. Hazard reduction refers to any treatment of inflammable materials that results in diminishing the chances of fire starting and spreading in them (Anonymous, 1953).

The behaviour and intensity of fire depends largely on the type quantity, size, arrangement, continuity, compactness, density, moisture content, specific heat, thermal absorptivity, chemical composition and other properties of fuel apart from topographic and climatic conditions of the locality. However, as far as fire prevention is concerned, only the continuity, arrangement and the quantity of fuel are the factors which can, from practical point of view, be modified to a certain extent so that even if fire is started it may not be too intense and may not spread due to lack of fuel. Hazard reduction for fire prevention, therefore, aims at reducing the fuel quantity and breaking its continuity or arrangement.

Build-up of organic debris

Grasses, ferns and other annuals or perenniels growing on the forest floor die and intermix with the leaves, flowers, fruits, gums, bark pieces and twigs shed by the trees as they grow. If the rate of decomposition is slow as in temperate areas, a litter layer develops on the forest floor. Such type of fine fuel is highly inflammable and most of the forest fires start in such type of fuel. Dead leaves and pine needles accumulating in undecomposed mats constitute a highly dangerous fire hazard. The amount, character, arrangement and inflammability of the surface litter are governed by species composition, stocking, age and general

* resently Conservator of Forests, Central Circle, Pasighat (Arunachal Pradesh)

condition of the stand. Estimates of rate of litter accumulation in different forest types found in India have been given by Seth *et al.* (1963). Dabral & Swarup (1963). Dabral & Sagar (1967), Champion and Seth (1968), Singh (1968), Misra (1969), Rao *et al.* (1972), Balasubramanayan (1980), Pradhan & Dayal (1981) etc. Summarising the data on litter production, mostly from India, Golley (1972) estimated the average litter production in tropical forests as 9.3 tonnes per ha per year. In general terms, Bazilevic and Rodin (1966) who presented a comprehensive review on the subject, concluded that the amount of foliage litter in tropical forests is 2.5 to 4 times that in temperate broad leaved forests and 4 to 7 times that in coniferous forests. However, the rate of decomposition in tropical areas is faster as compared to temperate areas.

Complete trees or their branches killed by insects, diseases. past fires, lightning, snow, landslips, floods, heavy winds etc.. dead bamboos and the unusable residue left in the area after logging viz branches, tops, bark, chunks, chips, cull logs, uprooted stumps, broken trees or limbs etc. also add to the amount of dead fuel. Such heavy or coarse type of fuel, aften called slash, is slow to decompose and takes a long time to become dry. But when it does become dry, it can support extremely hot and long duration fires. With traditional methods of logging, accumulation of logging slash can be very heavy, particularly in the hills. Sethi (1964) estimated that about 56% wood of high level deodar, kail and fir is left behind in the forests during logging operations. Hari Kant (1981) estimated that *in-situ* conversion of coniferous timber in the hills results in 30% wastage in the form of chips. According to him the wastage due to billeting of firewood by axe alone accounts for a wastage of 12-15% or about 18 million cubic meters equivalent to 12 million tons in the country. All these logging residues hamper regeneration of forests, serve as breeding centres of pests and diseases and build-up fire hazard.

Apart from the rate of accummulation and decomposition, the build-up of organic debris and logging slash is governed by the intensity of utilisation and the local demand. More complete the utilisation, less will be the quantity accumulating in the forest. The density of local population and the extent of demand determines the rate of accumulation. In fact apart from almost complete utilisation of more valuable species, the logging residues of even miscellaneous species are removed for use as firewood, particularly in easily accessible forest areas in India. Even the leaf litter and twigs lying on the forest floor are swept clean in some areas by nearby villagers Needles of deodar, spruce and blue pine are often removed from the forest for being used as manure. However, leaf litter as well as logging and other slash accumulates in remote and inaccessible forest areas situated away from habitation where there is no demand. The build-up of such dead organic material presents a serious fire hazard.

Grasses and Weeds as fire Hazard

Grasses colonise the forest floor wherever a gap occurs in the canopy and open areas, particularly in dry deciduous forests, usually have profuse grass growth and are extensively grazed. The graziers often set fire to such areas intentionally in order to obtain a new flush

of grass. Grasses and weeds provide flash fuel and pose extreme fire hazard. Entire plantations raised in such areas can be wiped out as a result of fire. Rate of spread of fire in grassy areas is very rapid since, once the fire starts, even the green grass blades dry out very quickly. Grasses and shrubs also provide vertical continuity of fuel and a surface fire buring through grasses and shrubs can turn into a crown fire engulfing the entire forest stands.

Possible Methods of Hazard Reduction

Silvicultural practices

In multi-storeyed forests or in close crops of mixed ages, flames of a surface fire burning in litter, grass or weeds may climb through the crowns of seedlings to those of saplings and successively into the crowns of poles and even large trees. Similarly dead trees or their limbs leaning against other trees may help a surface fire turn into a crown fire. It is, therefore, necessary to adopt good silvicultural practices including weeding, cleaning, removal of dead and dying trees, climber cutting, thinning etc. in order to break the vertical continuity of the fuels. This is particularly important in plantations raised in grassy areas or in forests where grasses constitute the main ground cover. Cutting and removal of grass at regular intervals for stall feeding should be preferred to grazing which increases the fire risk Complete elimination of the undergrowth is, however, not advocated except from firebreaks, roadsides or other areas of high risk. Diseased, dead, dying or top broken trees and dead bamboos must be immediately cut and removed from the area.

Agri-Silvicultural practices

Where plantations are raised in grassy areas or other areas having high fire hazard, the agri-silvicultural practices may be found to be effective in preventing forest fires. This is apparent in Haldwani area of U.P. where agricultural crops are grown with *Poplars* and *Eucalyptus* and the areas remain free from fire incidence. This may be due to reduction of fire hazard as a result of suppression of grass growth as well as continued surveillance against fire by the cultivators. Even the older plantations in which the cultivation of agricultural crops has been abondoned are found to be free from grass. Similar experience is common to other areas where agri-silviculture is practiced. Agri-silviculture, wherever possible, could, therefore, advantageously be used for reduction of fire hazard, apart from its other advantages as a combined production system.

Use of Chemicals

The efficiency of 2, 4-D, 2, 4, 5-T and other chemicals as effective weed killers has been amply demonstrated and they can be used in specific locations particularly in firebreaks, along roads, railway lines are similar situations for keeping down weeds and grasses as a measure of fire hazard reduction. Their wide spread use for keeping down such growth in all forest areas for breaking the vertical continuity of fuel can, however, not be recommended since apart from the cost involved, it may not be desirable to abolish the undergrowth altogether from several other points of view. Similarly, though theoretically it may be possible to fireproof the entire litter or slash in a forest area with the use of chemicals, the cost will be prohibitive, and the side effects may be injurious.

Fire lines or firebreaks

Firebreaks, fire-belts, fire-traces, fire-lines and open firelines are some of the terms used in India for cleared strips of varying width constructed or maintained in forest areas to work as a barrier for preventing fires crossing from one area to another. However, in some countries firebreaks, fire-lines or control lines are constructed round the perimeter of an active fire to prevent its further spread by isolating the fire from the fuel available ahead. Only the firebreaks constructed in advance and properly maintained as such can help in fire prevntion by breaking the horizontal continuity of fuels. Such firebreaks or fire-lines are constructed to serve several specific purposes (Davis, 1959).

1. To prevent the spread of fire to a particular area or property e.g. a plantation.
2. To prevent the spread of fire from a fire source e.g. a sawmill in or near a forest area or a forest area of especially high fire hazard.
3. To break up a large fuel area into relatively small blocks for the purpose of confining a fire if started in an area by isolation from adjoining areas.
4. To serve as ready-access routes for men and equipment.
5. To serve as base from which to work and counterfire if necessary during fire suppression.

While planning a firebreak network in a forest area, all natural features like extensive rocky outcrops, ridge tops, rivers and streams, swampy areas etc. and artificial features like road network, railway lines, power transmission lines, telephone lines, gas/oil pipe lines, coupe and compartment boundaries etc. which are usually kept free from vegetation should be taken into account in order to combine efficiency with economy. In fact the need to construct firebreaks will be more only in areas where roads and other similar features are lacking.

When breaks are specially constructed for preventing forest fires, their location with reference to probable sources of fire is important. The prevailing wind direction should also be considered while aligning the firebreaks since fire spreads along the wind. Other things being equal, a fire-line of a given width is more effective in stopping a fire approaching it at an acute angle rather than perpendicular to it The location and width of a firebreak must be governed partly by the rate of radiant heat transfer which decreases inversely with the square of the distance from fire (Luke, 1961). Steepness of the slope also influences the amount of radiant heat transferred to fuels above or below the fires; those above the slope receive more heat.

A net-work of external and internal firebreaks was introduced since the early days of systematic forest management in India and continues to be an important fire protection prescription even now. The width of these breaks varies from 1.5 m to 50 m. Generally speaking, the external fire-lines are wider (20 m to 50 m) whereas the internal fire-lines are narrow (1.5 m to 15 m). Width of 5m to 15 m is more common for internal fire-lines. Unfortunately the funds for construction and annual maintenance have not always been available. Cleaning maintenance of existing firelines is, therefore, often neglected though in some States regular maintenance is done and a width of 3 m to 5 m on both sides of forest roads is also fire

traced. The efficiency of the firebreaks depends on their maintenance and accumulation of dead fuel or growth of vegetation in the firebreak can seriously impair their efficiency by providing continuity of fuel. Raking or burning (fire tracing) of litter and removal of ground vegetation from fire-lines should be done ahead of the fire season Firebreaks cut to mineral soil are impracticable in many areas of the country because of the danger of soil erosion. Thus maintenance of firebreaks is a difficult and costly operation.

Firebreaks as a direct and unaided barrier to forest fires are frequently not very effective as a rapidly spreading fire under the infiuence of strong winds can often jump any firebreak that can be constructed and maintained at reasonable expenses. The efficiency of fire fighting organisation is more important for which the firebreaks provide ready access and can serve as operational base. Generally speaking firebreaks alone can not be relied upon to prevent or stop fires in a critical situation (Davis, 1959).

Evergreen firebreaks

An evergreen firebreak is a belt of living trees planted or conserved to suppress the growth of inflammable vegetation and to keep the soil condition as moist as possible against spot fires. The term, fire-belt is also sometimes used to denote a strip, open or planted with trees, maintained to check the spread of fire (Anonymous, 1953). Isolation strips of were or less fire proof evergreens can sometimes be planted to break-up large inflammable areas and where a suitable species is available, this practice is to be recommended. Stevens (1904) suggested planting of wide avenues of Shisham to work as fire-lines in India. Evergreen *Acacias* have been so used in South India (Champion and Seth, 1968). Species mostly planted for the purpose in Africa are *Eucalyptus cornata*, *E. saligna*, *E. diversicolor*, *E. paniculata*, *E fastigata*. *Casuarina*, *Sycarpia*, Poplars and Oaks at 3 m × 3m or 4 m × 4 m spacing. Other species recommended are *Convolvulus sepium*, *C simensis* and *Paspalum digitalum*. In India belts of deodar trees are known to serve as firebreaks. Evergreen species like *Wandlandia*, *Syzigium* etc. are sometimes grown around sholas in Tamil Nadu. *Strobilanthus* with its juicy stems often works as a natural firebreak (Masani *et al.*, 1957). In Manipur where the villages are located on hill tops, the villagers plant a belt of *Phoebe heinensis*, wild plantain, papaya, citrus and other evergreen species all round the village to keep the forest fires out. The ground below the dense growth of these species remains bare and works as a barrier to the spread of surface fires (Prasad 1981). In other areas strips planted with Agave or Euphorbias may serve the dual purpose of evergreen firebreak as well as live fence to keep away the cattle. Cultivation of suitable cash or food crops in wider firebreaks could also be considered. Fire resistent species to be planted as live barriers in different areas need to be identified.

Removal of inflammable material

Heavy accumulation of slash at certain points could be cut up and scattered over a wider area thereby disturbing the existing arrangement and continuity of the fuel. This used to be one of the standing instructions in the yellow pine and douglas fir forests in the South-west of U.S.A. (Chapman, 1919) and can be adopted in other areas for preventing the

potentially hot fires. The acumulated litter or slash can also be physically removed from the fire prone areas, purely as a measure of hazard reduction. The 'pulling top' method of slash disposal in U.S.A. (Munns, 1950) comprises of dragging away unutilised tops with limbs attached or whole accumulations of slash to reduce damage in case of accidental fires. Under Indian conditions, physical removal of logging residue or other material from forest is a costly proposition particularly in remote localities where there may be no local demand In such situations the possibilities of making charcoal in safe locations or installation of portable chippers may be investigated. Wherever possible such material could be removed for use in soil conservation works like gully plugging. Chir pine needles could be used for making hard-boards. Leaf litter could be used for composting. In fact it may be argued that burning the slash and other woody material is a criminal waste particularly when there is acute shortage of such material in the country and therefore, appropriate methods for its utilisation should be devised. However, cost considerations for the collection and transport of the bulky material have to be kept in view, while deciding the strategy for extraction of all woody material with a view to its complete utilisation.

Slash disposal

Slash disposal essentially means the treatment or handling of slash for the purpose of reducing hazards from fire, insects, fungi etc. and for providing the seeds with access to the soil (Anonymous, 1960). In India, burning for slash disposal is called debris burning and is usually done in areas from which vegetation has been cut down for clearing the ground for artificial regeneration. However, when litter or slash accumulating in a standing forest is disposed off by burning, the operation is referred to as controlled burning. Slash disposal here refers to debris burning only. Several methods used in other countries can be used singly or in combination for treating the slash wholly or partially. Such methods include live burning, progressive burning, piling and burning, broadcast burning, spot burning strip burning etc. (Munns, 1950, Anonymous, 1953).

Slash or debris burning has to be done in favourable weather and all necessary precautions have to be taken to ensure that fire does not escape and cause damage to the surrounding forests. Turner (1928) studied the problems of slash accumulation in chir pine forests of Almora and suggested methods for its disposal. His conclusion was th t slash must be disposed off safely before controlled burning in order to reduce the fuel in chir forests to the barest minimum.

Prescribed burning

Terms like departmental burning, prescribed burning, controlled burning, early burning etc. are often used rather loosely and often synonymously in India to denote the deliberate use of fire for reduction of available fuel in the forest. Generally speaking departmental burning is a wider term which includes debris burning carried out in logged areas for clearing the site as well as controlled burning carried out in standing forests. Controlled burning has been defined as any deliberate use of fire whereby burning is restricted to a pre-determined

area and intensity or deliberate burning of a prescribed area at a pre-determined time (Anonymous, 1953). Early burning is defined as controlled burning early in the dry season before the leaves and undergrowth are completely dry or before the leaves are shed, as an insurance against later fire damage (Anonymous, 1953). Light burning is a form of prescribed burning at intervals of time so spaced that only a relatively small amount of fuel accumulates between successive burnings and accidental fires will be of low intensity, cause little damage and be easily controlled (Munns, 1950). On the other hand prescribed burning is defined as the application of fire to land under such conditions of weather, soil moisture, time of day and other factors as presumably will result in the intensity of heat and spread required to accomplish specific silvicultural, wildlife, grazing or fire hazard reduction purposes (Munns, 1950).

The results of controlled burning may not infrequently be different to that expected from wildfire. In fact a deliberate though often unrealised, loss is incurred in controlled burning as an insurance against a possible much greater loss at a time when fire would be more difficult to control. This is the reason why Champion and Seth (1968) called controlled burning as a lesser evil Prescribed burning on the other hand, is a refinement of controlled burning in which the fact that fire causes damage is acknowledged and conscious effort is made to restrict this damage to the lowest possible level.

The use of fire in forest management may be prescribed not only for hazard reduction but also for many other uses including improved regeneration, recycling of nutrients, control of pests and diseases, improvement of grassland, management of wildlife parks, modification of cover type etc. The major argument for using fire for these purposes is its cheapness in comparison to other methods and if cost was no consideration, other methods can very well be adopted.

Controlled burning was successfully tried in the chir forests in India in the beginning of the present century and is now a standard practice. The technique has been described by Turner (1928) and Dent and Dabral (1947). Detailed studies on the techniques of controlled burning in other types of forest do not appear to have been conducted though such burning is carried out in sal and several other areas as well Refinements of controlled burning techniques in the form of prescribed burning have yet to be done.

Careful planning is necessary for carrying out prescribed burning. The intensity and duration of heat needed to achieve the desired results have to be determined in advance. Areas in which prescribed burns are to be carried out have to be properly identified on the maps. Prevailing winds, topography of the area, available fuels and their conditions, possibilities of spread of fire to near-by area etc have to be carefully studied so that burning may be carried out at the appropriate time. The available fuel may have to be removed in advance particularly when there is huge accumulation so that the intensity of heat may be kept at the desired level The men involved in prescribed burning have to be properly briefed regarding when where, how and in what sequence fires are to be set. Fire fighting equipment has to be kept ready in order to deal

with possilbe spread of fire to other areas. In fact a prescribed burning plan, akin to the fire suppression plan, has to be drawn up and got approved in advance in countries like New Zealand before such burning can be carried out.

Unfortunately prescribed burning in India is sometimes carried out by unskilled labourers who are not sufficiently trained in the job. Some people even allege that occurrences of accidental fires are sometimes branded as prescribed burning by unscrupulous forest officials. Although such allegations may not be true, the fact remains that a highly technical operation like prescribed burning must be planned in advance and carried out under the direct supervision of a responsible officer. Prescribed burning can also provide an opportunity for actual training in fire fighting. Detailed controlled burning or prescribed burning guides for specific locations need to be drawn up as done in other countries.

Discussions and Conclusions

For obvious reasons fire prevention must from the backbone of forest fire protection strategy in India. For this purpose, apart from adopting various methods for reduction of risk (Sangal, 1982), it is also necessary to take all possible measures to reduce the hazard. It is difficult to say with certainty as to what method of hazard reduction is ideal for Indian conditions. Based on his experience in U.P., Hakimuddin (1953) left that construction and maintenance of a network of fire-lines is a wastage of money as well as space and he advocated abolition of fire-lines in order to save huge sums of money being spent on their maintenance and to utilize the space for growing trees. He preferreed burning the forests departmentally (controlled burning) early in the fire season in order to save the forests from accidental burning since there wiil be nothing left to burn. He also felt that sal regeneration problem would be solved as a result of departmental burning and weed and climbers will be reduced thereby saving expenditure on cultural operations. On the other hand Masani *et al.* (1957) felt that early burning is difficult to control, requires skill and experience, often degenerates to free burning and has proved a failure in many parts of the country, According to Buit (1962) firebreaks, watch and ward, early burning etc. have largely proved ineffective in many areas mainly due to poor maintenance of fire lines, lack of roads, dearth of labour, public apathy and lack of consciousness in forest personnel.

It will be clear from the above observations that there is nothing basically wrong with the techniques as such, provided they are executed properly. The following conclusions can be derived as far as the situation in India is concerned.

1. Weeding cleaning, climber cutting, thinning and other tending operations should be carried out timely in forest areas depending upon the silvicultural requirements. These operation will *inter-alia* reduce fire hazard by breaking the vertical continuity of the fuels.

2. The practice of agri-silviculture may often be found to be useful in reducing fire hazard, apart from its other advantages as a combined production system.

3. The use of chemicals on field scale for eradication of grasses and weeds as a hazard reduction measure or for fire proofing of litter is ruled out at present due to cost considerations.

4. Detailed studies are necessary in natural forests as well as plantations for quantifying the rate of accumulation and decomposition of litter and slash material. Fuel type classification system and fuel mapping techniques also need to be developed.

5. Fire-lines serve a useful purpose in fire prevention by breaking the horizontal continuity of the fuel and the existing natural and artificial features, direction of prevailing winds, fuel characteristics, fire behaviour, possible sources of ignition etc. should be kept in view while deciding their size and alignment. In order to be effective the fire-lines have to be properly maintained.

6. Evergreen firebreaks may be found useful in certain localities. Fire resistant species for planting as evergreen firebreak need to be identified for different areas.

7. All slash accumulating as a result of logging activities, insect or disease epidemics, wind or past fires etc. should be removed for proper utilisation or otherwise disposed off as quickly as possible. In any case slash must be removed and disposed off safely beforehand if the area is to be control burnt.

8. Detailed studies need to be conducted on the behaviour of fire under different types of fuel under varying conditions of climate and topography in order to provide not only a scientific basis for hazard reduction through prescribed burning but also for prediction of fire danger, guidance in fire suppression etc.

9. Detailed plans for prescribed burning need to be prepared in advance of the operation where such burning may be prescribed for hazard reduction or other specific purposes. Close supervision of the operation by responsible officers is also necessary to ensure success.

10. Requisite skills in prescribed burning as a measure of hazard reduction need to be developed through intensive training.

SUMMARY

Hazard reduction for fire prevention in forest areas can be achieved by reducing the quantity, breaking the continuity and disturbing the arrangement of forest fuels Factors affecting the build-up of fire hazard have been described and an over-view of the possible techniques of hazard reduction in Indian forests has been presented. It has been concluded that properly maintained fire-lines can help in breaking the continuity of the fuels but they cannot be relied upon to contain and localise the fires by themselves. Planting of fire resistant species in covered firebreaks holds greater promise and such species need to be identified for different areas. Silviculural practices like weeding, cleaning, thinning etc. and agri-silvicultral practices can help considerably in reducing fire hazard. Need for refining the technique of prescribed burning through research on fire behaviour under variable conditions, thorough training of personnel and close supervision of the operation has been stressed

वनों में आग लगने की रोकथाम के लिए इसके खतरे घटाना

लेखक पी०एम० संगल

सारांश

वन क्षेत्रों में आग लगना रोकने के लिए इसके खतरों को वनों में ईंधन की मात्रा को कम करके, उनकी निरन्तरता को तोड़कर तथा उसके विन्यास में विघ्न डालकर घटाया जा सकता है। यहां पर अग्र संकट के जमाव को प्रभावित करने वाले कारणों का वर्णन किया गया है तथा भारतीय वनों में इसका संकट घटाने की संभावित प्रविधि का विहगंम दर्शन प्रस्तुत किया गया है। निष्कर्ष में यह बताया गया है कि ठीक तरह से रखवाई गई आगरोधी पट्टियां ईंधन की निरन्तरता तोड़ने में तो सहायक होती है परन्तु आग रोकने और उन्हें स्थान सीमित बनाने में मात्र उन्हीं पर निर्भर नहीं रहा जा सकता। आवृत्त की हुई अग्निरोधी पट्टियों में अग्नप्रतिरोधी वृक्ष जातियां लगाना अधिक संभावना वाला है तथा विभिन्न क्षेत्रों के लिए ऐसी वृक्ष जातियां निश्चित करने की आवश्यकता है। निराई, सफाई, विरलन आदि वन संवर्धन क्रियाएं तथा कृषि–वानिकी प्रणालियां भी अग्नि लगने का संकट घटाने में काफी सहायक हो सकती है। तरह-तरह की दशाओं में आग लगने पर उसके व्यवहार का अनुसंधान करके निर्धारित दाहन क्रिया में परिष्कार कर्मचारियों को समुचित प्रशिक्षण तथा कार्य कराते समय उसकी भलीभांति पर्यवेक्षण कराने की आवश्यकता पर भी जोर दिया गया है।

References

Anonymous (1953) British Commonwealth Forest Terminology; Empire Forestry Association, London, WC 2.

Anonymous (1960). Indian Forest and Forest Products terminology; *Ind. For. Rec. (N.S.) Silv.* 10 (6) (Manager of Publications, Delhi).

Balasubramanyan, K. (1980). Litter production in the dry evergreen forests near Pondicherry, Cormandal coast; *Paper presented at the Second Forestry Conference*, F.R.I. & Colleges, Dehra Dun (Mimeo).

Bazilevic, N.I. and L.E. Rodin (1966). The biological cycle of nitrogen and ash elements in plant communities of the tropical and sub-tropical zones; *Forestry Abstracts* 27 : 357–68.

Buit, S.S. (1962) Forest protection in Maharashtra State; *Maharashtra State Forest Centenary*, Pune.

Chapman, H.H. (1919). Development of a brush disposal policy for the yellow pine Forests of South West. *Amer. J. For.* 17 : 693-703.

Champion, H.G & S.K Seth (1968). *General Silviculture for India*; Govt. of India, Pub. Branch, Delhi-6.

Dabral, B.G. and Ram Swarup (1963). Some observations on litter accumulation under bamboo; Paper presented at the *All India Bamboo Study Tour and Symposium*, F.R I , Dehra Dun.

Davis, K.P. (1959). Forest fire : control and use; McGraw Hill Book Co. INC, New York.

Dent, T.V. and S N. Dabral (1947). Controlled burning in a chir plantation; *Forest Bull.* No. 131, Silv. Ser. F.R.I., Dehra Dun.

Golley, F.B. (1962). Summary of papers *Symposium on tropical ecology with an emphasis on organic productivity,* (P M. Golley and F.B. Golley, Eds.) Institute of Ecology, University of Georgia, U.S.A.

Hakimuddin, M. (1953). Forest fires; *Ind For.*, 79 (10) 572–573.

Hari Kant (1981). Logging waste-a potential source of energy; *Ind. For.*, **107** (12) : 818-822.

Luke, R.H. (1961). Bush fire control in Australia; Hoddar & Stoughton, Melbourne.

Masani, N.J.; K. Kadambi and V.P. Mathur (1957). Note on forest fire protection in India; *Ind. For.*, 83 (5) : 339–346.

Misra, R. (1969). Primary production of chakia forests and the IBP/PT Study of organic productivity and nutrient cycling in monsoon forests; *Proc. IUCN 10th General Assembly and 11th Technical Meeting*, Delhi.

Munns, E.N. (Ed.) (1950). Forestry Terminology; a glossary of technical terms used in forestry; Soc. of American Foresters, Washington, D.C.

Pradhan, I.P. and R. Dayal (1981). Farm forestry in agicultural economy; *Ind. For.* 107 (10) : 665–667.

Prasad, G.K. (1981). Personal Communication.

Sangal, P.M. (1982). Risk reduction for forest fire prevention in India—some suggestions *(under publication).*

Seth, S.K.; O.N. Kaul and A C. Gupta (1963). Some observations on nutrient cycle and return of nutrients in plantations at New Forest, *Ind For.*, 89 (2) : 90–98.

Sethi, Y.R. (1964). Need for improved logging in the hills, *Ind. For*, 90 (3) : 164–167.

Singh, K.P. (1968). Litter production and nutrient turn over in deciduous forests of Varanasi. *Proc. Symposium on recent advances in tropical ecology*, 2 : 655–665.

Stevens, E.R. (1904). Fire Protection—a suggestion, *Ind. For*, 30 (7) : 525.

Rao, B.K. Subba; B G. Dabral and S.K. Pande (1972). Litter production in forest plantations of chir *(Pinus roxburghii)*, teak *(Tectona grandis)* and sal *(Shorea robusta)* at New Forest, Dehra Dun; *Proc. Symposium on Tropical Ecology with an emphasis on organic production*, (P.M. Golley and F.B. Golley, Eds.) Institute of Ecology, University of Georgia, U.S.A.

Turner, J.E C. (1928). Slash in Chir pine (*Pinus longifolia*) forests : Causes of formation, its influence and treatment *Ind. For. Rec.* Vol. XIII pt. VII (Silv. Ser.) Govt. of India, Publ. Br., Delhi.

———

RETURN OF NUTRIENT BY THE LEAF-LITTER OF BLUEGUM *(EUCALYPTUS GLOBULUS)* AND BLACK WATTLE *(ACACIA MEARNSII)* PLANTATIONS OF NILGIRIS IN TAMIL NADU

C. VENKATARAMANAN*, B. HALDORAI**, P. SAMRAJ**, S.K NALATWADMATH** AND C. HENRY**

Introduction

In natural forests and man-made protected plantations, cycling of nutrients is an important aspect as considerable amounts of nutrients are returned to the soil through leaf-fall and made available for re-absorption. This depends upon the amount and composition of leaf-litter which is useful in interpreting the soil fertility status, rate of decomposition etc. Litter production is also related to many other biological important aspects.

Studies on the chemical composition and total quantity of the leaf-litter of the Bluegum, Black wattle plantations in the Nilgiris in Tamil Nadu state have been worked out as no such earlier work has been done.

Methods and Materials

The leaf-litter samples were analysed every month for dry matter, total N, P, K, Ca., Mg and organic carbon by standard methods (Jackson, 1962 and Piper, 1950) from five plots of 1.5 m × 1.5 m located in the Bluegum and Black wattle (spaced at 2 m × 2 m i.e. 2500 trees/ha) plantations (12 years old) in the Nilgiris, at CS & WCR & TI, Research Farm at Rees' Corner, Ootacamund, Nilgiris. The climatological data recorded at the meteorological observatory of the Research Farm (1974–78) was used for the study.

Results and discussions

The amount of leaf-litter accumulated every month, dry matter and climatological parameters are given in Table 1. From Table 1, it was observed that maximum leaf-fall and its accumulation (Average of 7 years from 1972–78) was during September, November, December, January and February (about 54% of annual leaf-fall) in the case of Bluegum plantation (Fig. 1) and during March, April, May, June and July (about 55% of annual leaf-fall) in the case of Black wattle plantation (Fig. 3). The minimum leaf-fall was recorded during April and May in the case of Bluegum plantation and during October, November and December in the case of Black wattle plantation. The total annual leaf-litter accumulation (average of 7 years from 1972–78) in the Bluegum and Black wattle plantations were 1935 and 960 kg/ha and this was low as compared to 2121 kg/ha in the case of *Shola* (natural evergreen forests of the Nilgiris in Tamil Nadu) (Venkataramanan, *et al.* 1978) and was very low as compared to Sal, Teak and Chir where the accumulation of leaf fall was reported as 9500, 7700 and 8500 kg/ha (Srivastava, *et al.* 1972).

* Jr. Tech. Officer, CS & WCR & TI, DEHRA DUN.
** Sr. Res. Asstt, Scientist (S-2), Scientist (S-1) and Technical Asstt. CS & WCR & TI, Research Centre, Ootacamund.

The maximum leaf-fall (223 kg/ha) and accumulation in the case of Bluegum occurs during September when the plant begins to flower in the Nilgiris. In general, leaf-fall in Bluegum was observed more during the winter months when minimum temperature values are low, periods of maximum sunshine hours and less rainfall (December, January and February).

In the case of leaf-fall of Black wattle, maximum leaf-fall of 114 and 126/ha were observed, especially to take place during June and July when there were high wind velocities (9 & 8 kg/hour). Probably this may be due to the smallness of leaves (needle like).

Leaf-fall in the Bluegum increases from May to February (S.W. and N.E. monsoon periods and winter months) and decreases during March and April (summer months) and the trend is in a way similar to that of leaf-fall of *Shola*. But in the case of Black wattle, leaf-fall increases from January to July (later part of winter month, summer and S.W. monsoon) and decreases from August to December (N.E. monsoon and former part of winter months). On an average, return of leaf-litter from Bluegum and Black wattle to the soil ranges between 82 to 223 and 52 to 126 kg/ha/month respectively.

The composition of nutrients in the leaf-litter is given in Table 2. It was observed that the bluegum and black wattle leaf-litter contains the highest amount of Nitrogen (1.4—1 9% and 2 0—2.7%) followed by Calcium (0.83—1.10% and 0.28—0.44%). Potassium (0.14—0.32% and 0.22—0.65%) and Magnesium (0.07—0.19% and 0.06—0 16%) respectively. Black wattle being leguminous, its leaf-litter contained more of N_2 content than that of bluegum.

Monthly variation of N, Ca, K, Mg and P show interesting trends. In the case of leaf-litter of Bluegum, Nitrogen has three peaks in June, August and November; Calcium has two peaks in April and June; Potassium has three peaks in June, July and October and Magnesium has three peaks in April, June and July (Fig. 2) These peaks show maximum return of nutrients during the different periods of leaf-fall. In the case of leaf-litter of Black wattle, (Fig. 4) Nitrogen has two prominent peaks in August and November; Calcium has two peaks in June and August; and Potassium has one very prominent peak in March. It is interesting to observe that Nitrogen content in the leaf-litter is more only during the time when the leaf-fall decreases. It may be probably due to the fact that Nitrogen is not recycled to a greater extent but considerable portion gets fixed in the nodules of the roots of the species.

There appears to be a uniform return of Phosphorus through leaf-litter in Bluegum and Black wattle. This may be due to either low requirements and hence low contents of Phosphorus in the foliage of Bluegum and Black wattle or due to the non-availability of P from the soil on aacount of high fixation of the latosols of Nilgiris. This needs further study.

The macro nutrients added to the soil by way of Bluegum leaf-litter amounts to 31 kg/N/ha, 0.8 kg P/ha, 4.3 kg K/ha, 18.8 kg Ca/ha, 2.1 kg Mg/ha in addition to 1548 kg Organic matter/ha which contains a major quantity of various essential micro-nutrients. The macro nutrients added to the soil by way of Black wattle leaf-litter amounts to 22.1 kg N/ha, 0.5 kg P/ha, 3.4 kg K/ha, 3.3 kg Ca/ha, 0.9 kg Mg/ha in addition to 662 kg Organic matter/ha.

Table 1

Amount of leaf-litter (kg/ha) and climatological parameters

Month	Leaf litter Black wattle Oven dry wt.	(Av. of 1972-78) Bluegum Oven dry wt.	Total rainfall (Av. of 1974–78) (mm)	Sunshine (hours)	Mean maximum tempera-ture (°C)	Mean minimum tempera-ture (°C)	Mean wind velocity (km/hr.)	Mean Evapo-ration (mm)
January	61	204	2.22	297.12	18.78	6.52	4.70	117.58
February	83	219	11.98	257.28	18.20	8.10	4.78	123.64
March	93	141	10.12	289.30	20.72	10.38	6.82	217.16
April	96	82	52.02	243.92	21.74	12.08	5.88	157.10
May	97	86	162.14	210.52	20.90	12.62	4.24	119.50
June	114	149	113.12	131.06	17.82	11.86	9.30	99.94
July	126	127	155.02	76.46	16.94	11.90	8.00	78.92
August	70	119	142.86	103.40	16.86	11.80	7.38	78.96
September	63	223	143.74	139.18	17.90	11.44	4.44	84.62
October	52	187	121.60	163.04	18.00	11.16	3.92	79.00
November	52	198	223.98	178.60	17.42	10.04	4.42	77.86
December	53	200	17.10	244.90	18.00	8.06	4.76	96.72
Total	960	1935	1155.90	2334.78				

Table 2

Chemical composition of Bluegum and Black wattle leaf-litter – Ootacamund

	Months												
	Jan.	Feb.	March	April	May	June	July	Aug	Sept.	Oct.	Nov.	Dec.	Av.
					Nitrogen, N (%)								
Bluegum	1.5	1 4	1.4	1.4	1 6	1.7	1.5	1 8	1.6	1.8	1.9	1.5	1.6
Black wattle	2.2	2.0	2 1	2.0	2.1	2.2	2.2	2.7	2.4	2.4	2.6	2.3	2.3
					Phosphorus, P (%)								
Bluegum	0.03	0.04	0.04	0 04	0.05	0.06	0.06	0.05	0 03	0.03	0 04	0.04	0.04
Black wattle	0.05	0.05	0.04	0.04	0 05	0.04	0 06	0.05	0.05	0.05	0.06	0.05	0.05
					Potassium, K (%)								
Bluegum	0.17	0.22	0.20	0.22	0.19	0.32	0.32	0.14	0 17	0 32	0 18	016	0.22
Black wattle	0.37	0.55	0.65	0.41	0 22	0 33	0.25	0.29	0.24	0.28	0.27	0.35	0.35
					Calcium, Ca (%)								
Bluegum	0.92	0.97	0.98	1.10	0.94	1.04	0.83	0.94	0.94	0.97	1.03	0.98	0.97
Black wattle	0.28	0.30	0 30	0.32	0.29	0.39	0.29	0 39	0.36	0.36	0.39	0.44	0.34
					Magnesium, Mg (%)								
Bluegum	0 08	0.09	0.08	0.14	0.10	0.19	0.19	0.12	0.10	0 07	0.08	0.08	0.11
Black wattle	0.06	0.06	0.06	0.08	0.07	0.11	0.16	0.12	0.11	0.08	0.09	0.06	0.09

A comparative statement showing the macro-nutrients added to the soil by way of *Shola*, bluegum and black wattle leaf-litter is given in Table 3.

Table 3

Macro-nutrients added to the soil by leaf-litter of Shola, bluegum and black wattle in Ootacamund.

Vegetation	Annual addition of macro-nutrients (kg/ha) N	P	K	Ca	Mg	Org. matter
Shola	23.1	1.3	11	34	5	1956
Bluegum	31	0.8	4.3	18.8	2.1	1548
Black wattle	22.1	0.5	3.4	3.3	0.9	662

From the data in Table 3, it was observed that leaf-litter of *Shola* is rich in nutrients like N, K, Ca and Organic matter followed by Bluegum and Black wattle.

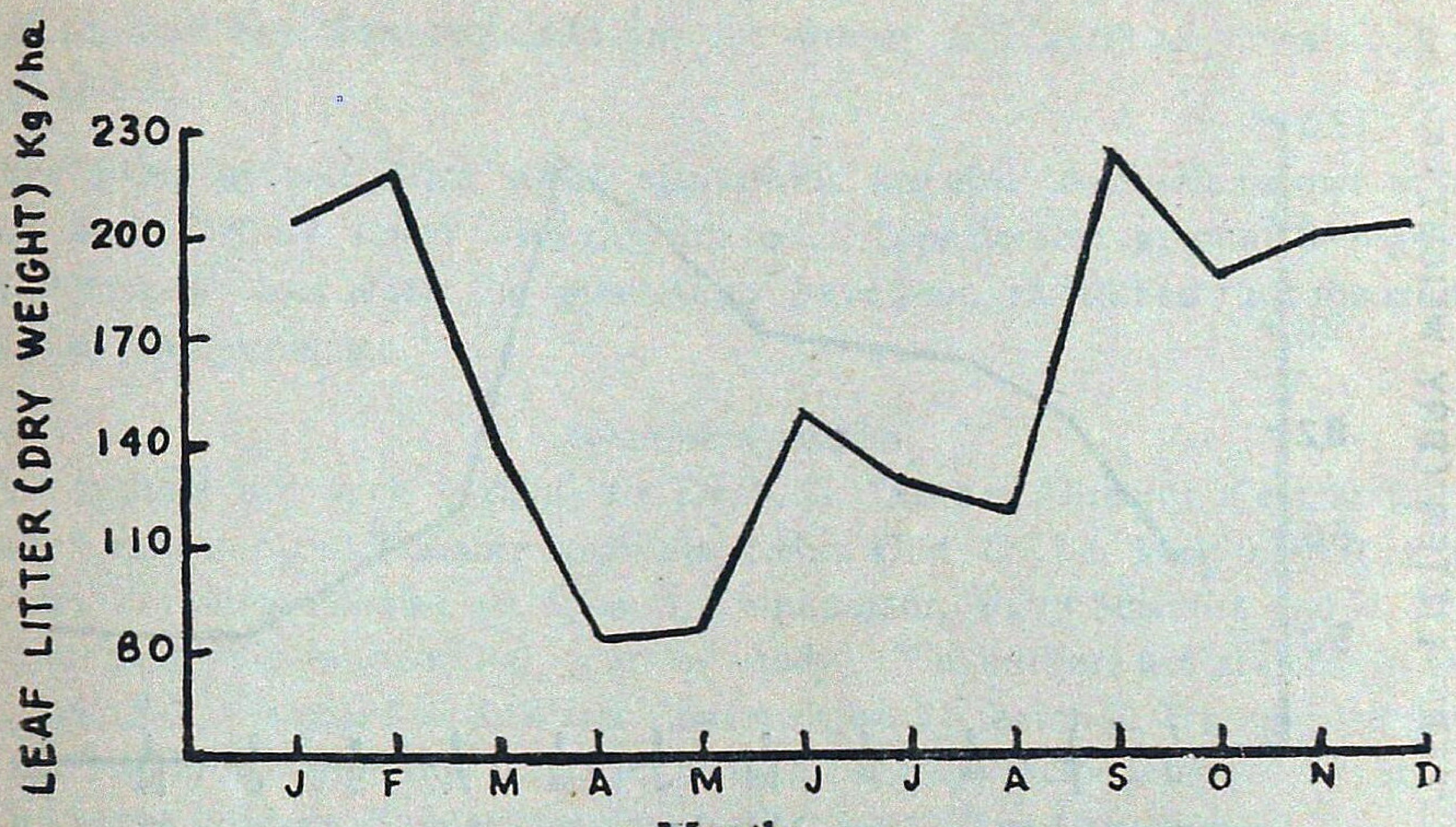
Table 4

Chemical properties of soils under different landuses – Ootacamund.

Landuse	Depth (cm)	Organic carbon	Nitrogen (%)	Exchangeable (m.e. %) Ca	K
Initial analysis at the start of the experiment					
	0-15	2.86	0.10	9.7	1.1
Final analysis at the end of the experiment (12 years old plantation)					
Eucalyptus globulus	0-15	5.41	0.61	16.4	1.2
	15-30	3.23	0.29	11.3	0.8
	30-60	1.79	0.18	8.0	0.6
Acacia mearnsii	0-15	5.71	0.65	13.8	1.7
	15-30	3.20	0.35	10.2	1.1
	30-60	1.91	0.22	6.8	0.7

Comparing the results of analysis of 0-15 cm soil layer at the start of the experiment and after 12 years (Samraj *et al* 1980), it is very clear that the 0-15 cm soil layer has been enriched with respect to organic carbon, total nitrogen, exchangeable calcium and potassium contents This enrichment occurred in the last twelve years is due to recycling of mineral nutrients from deeper layers. A comparison of 0-15 cm and 30-60 cm soil layer at the final analysis also shows that the status of Organic carbon, total nitrogen, exchangeable calcium and exchangeable potassium is very high in 0-15 cm soil layer as compared to 30-60 cm soil layer.

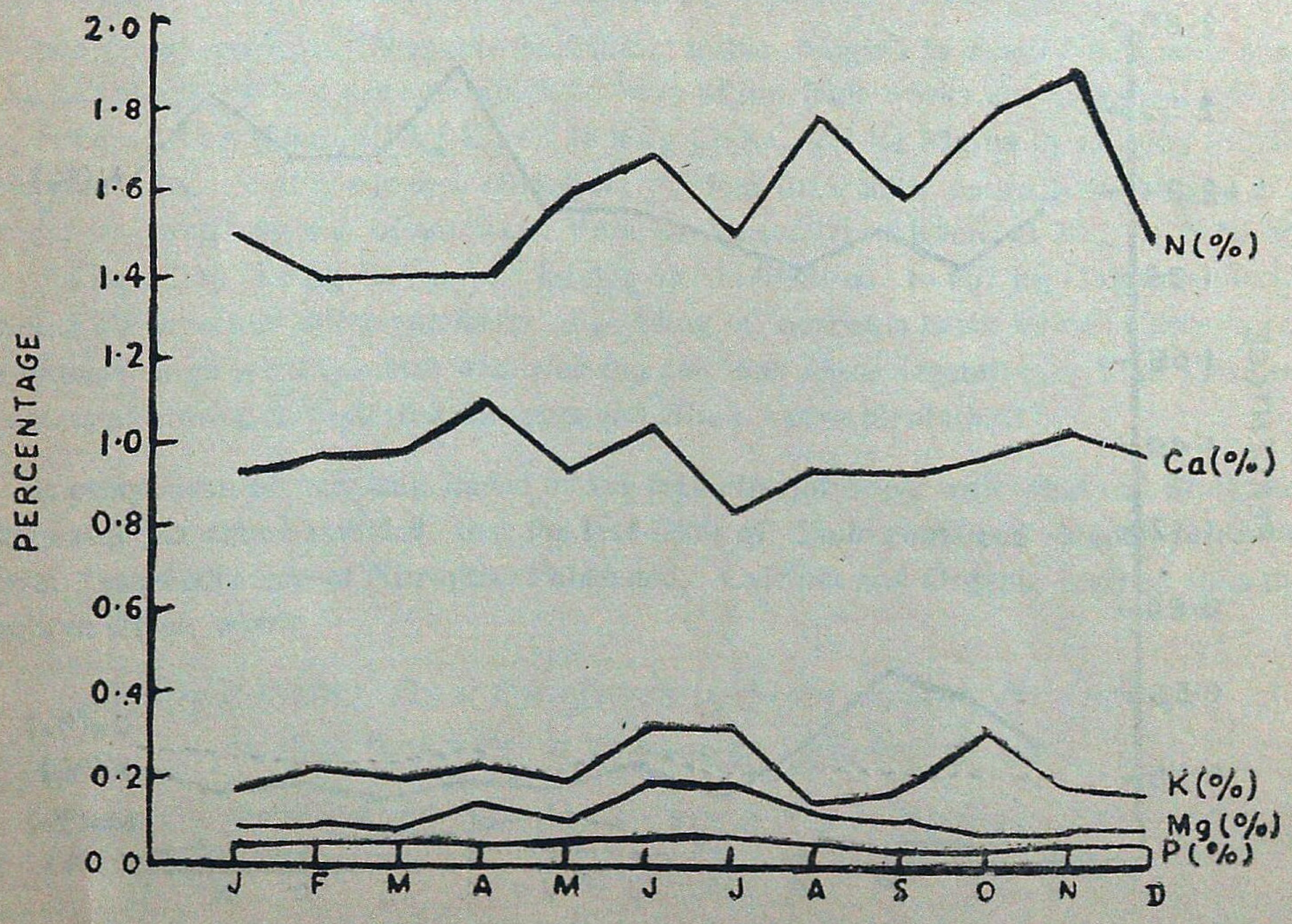
Fig. 1



Months

Bluegum leaf-litter accumulation during different months

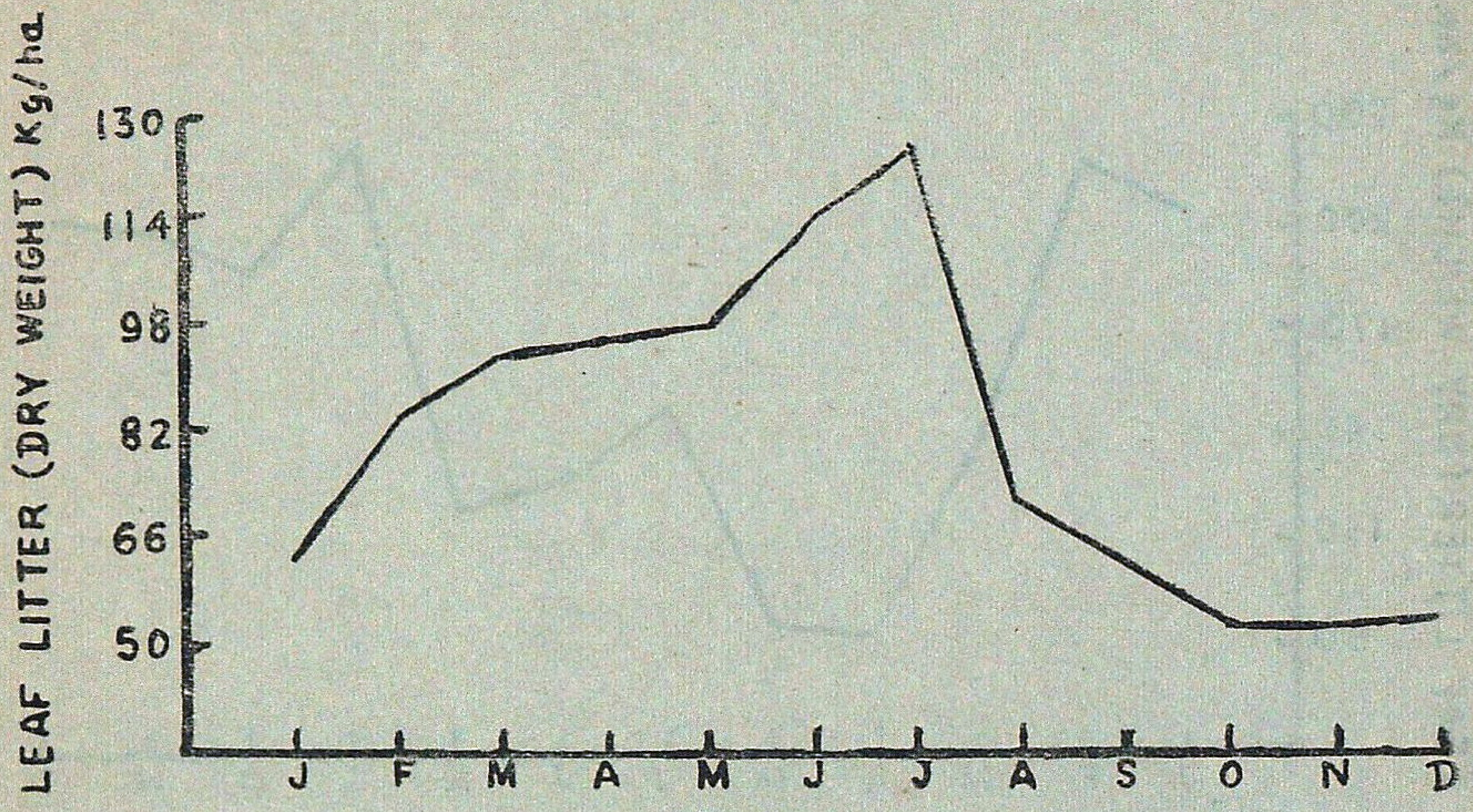
Fig. 2



Months

Composition of Nutrients in the Bluegum leaf-litter

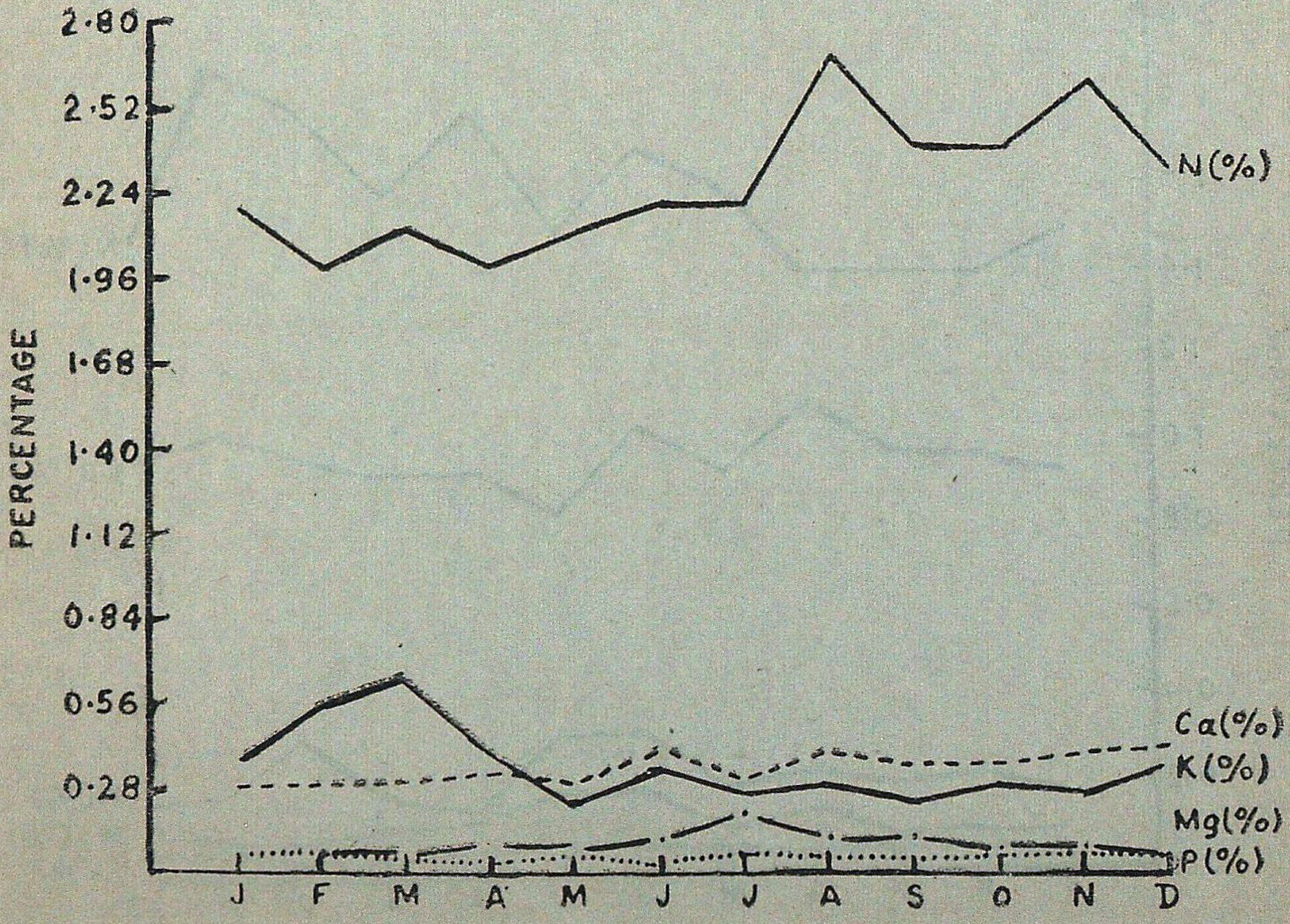
Fig. 3



Months

Black wattle leaf-litter accumulation during different months

Fig. 4



Months

Composition of Nutrients in the Black wattle leaf-litter

Barring Organic Carbon which is fixed from atmosphere to a large extent, nitrogen, calcium and potassium must have been recycled from the deeper soil layers as revealed by their low analysis (Table 4).

Thus Bluegum and Black wattle plantations are able to recycle its own nutrient and maintain a high fertility status with rich top soil. Considerable amount of organic matter accumulates over the floor where the plantations have been raised and thus the land will not be prone to erosion problems.

Acknowledgements

The authors are very grateful to Dr. K.G. Tejwani, Director, Central Soil & Water Conservation Research and Training Institute, Dehra Dun for his keen interest in this study. The authors are also grateful to S/Sh. S. Chinnamani, Plant Scientist and R. Subbayyan, SRA (PS) for their help in the initial years of study. The authors are grateful to Dr. Pratap Narayan, Sci. S-2, Central Soil & Water Conservation Research & Training Institute, Dehra Dun for his help in interpretation of some analytical data. Help rendered by Shri K. Vasu, SSA (Lab.) in the analysis of plant samples is acknowledged and appreciated.

SUMMARY

Studies on the chemical composition and total quantity of the leaf-litter from the *Eucalyptus globulus* and *Acacia mearnsii* plantations have been worked out.

***Eucalyptus globulus* (Bluegum) leaf-litter in the Nilgiris in Tamil Nadu adds annually 1935 kg/ha of litter (Oven dry wt.) which by way of nutrients works out to annual addition of 31 kg N/ha, 0.8 kg P/ha, 4.3 kg K/ha, 18.8 kg Ca/ha, 2.1 kg Mg/ha in addition to 1548 kg organic matter/ha. *Acacia mearnsii* (Black wattle) leaf litter adds annually 960 kg/ha of litter (Oven dry wt) which by way of nutrients work out to annual addition of 22.1 kg N/ha, 0.5 kg P/ha, 3.4 kg K/ha, 3.3 kg Ca/ha, 0.9 kg Mg/ha in addition to 662 kg Organic matter/ha, containing all important micro-nutrients. Recycling of nutrients in the above plantation keeps the land under high fertility status with rich top soil and dense vegetation. Thus there will be no problem of erosion in protected Bluegum and Black wattle plantations.**

A comparison of nutrients added by the leaf-litter of *Shola* with that of Bluegum and Black wattle plantation revealed that the leaf-litter of *Shola* contained higher percentage of nutrients (especially that of Nitrogen, Potassium, Calcium and Organic matter) than that of Bluegum or Black wattle.

तमिलनाडु के नीलगिरि प्रदेश में नील युक्लिप्टस (युकेलिप्टस ग्लोबुलुस) और कृष्ण वाटल (अकेसिया मियर्नसिआई) में पर्णस्तरण द्वारा पोष्याहारों की वापसी

लेखक सी० वेंकटरमनन्, बी० हल्दोराय, पी० साम्राज, एस०के० नलत्वादमठ व सी० हेनरी

सारांश

युकेलिप्टस ग्लोबुलुस और अकेसिया मियर्नसिआई रोपवनों से मिले पर्णस्तरण के रासायनिक संगठन और इसकी कुल मात्रा का अध्ययन किया गया है।

युकेलिप्टस ग्लोबुलुस (नील युकेलिप्टस) पर्णास्तरण तमिलनाडु के नीलगिरि प्रदेश में प्रतिवर्ष 1935 किग्रा०/हेक्टे० आस्तरण (नामक शुष्कभार) की वृद्धि करता है जिसकी पोष्याहारों के रूप में वार्षिक वृद्धि 31 किग्रा०/नाइट्रोजन/हेक्टे०, 0.8 किग्रा० फास्फोरस/हेक्टे०, 4.3 किग्रा० पोटाशियम/हेक्टे०, 118 किग्रा० कैलशियम/हेक्टे० 2.1 किग्रा० मैंगनीशियम/हेक्टे० तथा 1548 किग्रा० जैव पदार्थ/हेक्टे० की वृद्धि होती है। अकेसिया मियर्नसिआई (कृष्णा वाटल) से प्रतिवर्ष 960 किग्रा/हेक्टे० पर्णास्तरण (तापक शुष्क भार की वृद्धि हो रही है जिसका पोष्याहारों के रूप में 22 किग्रा० नाइट्रोजन/हेक्टे० 0.5 किग्रा० फास्फोरस/हेक्टे०, 3.4 किग्रा० पोटाशियम/हेक्टे०, 3.3 किग्रा० कैलशियम/हेक्टे०, 0.9 किग्रा० मैगनीशियम/हेक्टे० तथा 662 किग्रा० जैव पदार्थ/हेक्टे० वार्षिक वृद्धि कहा जा सकता है जिसमें सभी छोटे पोष्याहार होते हैं। इन रोपवनों में पोष्याहारों का पुनर्चक्रण होता रहने से इस भूमि में ऊपर की मृदा सम्पन्न और अत्यधिक उर्वर बनी रहती है और वनस्पति सघन होती है। अतः संरक्षित नील युकेलिप्टस और कृष्ण वाटल रोपवनों में मृदा अपक्षरण की कोई समस्या उत्पन्न नहीं होगी।

शोला वनों के पर्णास्तरण द्वारा मिलाए पोष्याहारों की तुलना नील युकेलिप्टस और कृष्ण वाटल रोपवनों के साथ करने पर पता चला कि शोला वनों के पर्णास्तरण में पोष्याहारों का प्रतिशत अधिक (वि ाषकर नाइट्रोजन पोटाशियम, कैलशियम और जैव ऐदार्थ का) बमुकाबले नील युकेलिप्टस या कृष्ण वाटल वनो के।

References

Jackson, M L, (1962). *Soil Chemical anaylsis*, Asia Publishing House, New Delhi.

Piper, C.S. (1950). *Soil and Plant analysis.* The University of Adelaide, Adelaide.

Samraj, P., S. Chinnamani, B. Haldorai, C. Henry and S K. Nalatwadmath (1980). Small catchments studies on the effect of forest covers both in natural degraded *Shola* forests and converted man-made forests in the Nilgiris (Tamil Nadu). Paper presented in the National sysmposium on Soil and Water Management C. S. & W. C. R. & T. I., Dehra Dun.

Srivastava, P.B., O.N. Kaul and H N. Mathur (1972). Seasonal variation of nutrient content of the foliage and their return through leaf-litter in some plantation ecosystems. Proc. symposium on Manmade Forests in India; (*Soc. of Indian For.*).

Venkataramanan, C. and S. Chinnamani (1978). A preliminary note on the return of Nutrient by the-leaf litter of wet (montane) temperate evergreen *Shola* forests of Nilgiris. *Indian For.*, **104** (6) : 450-456.

SUPPLEMENTING RESIN PRODUCTION BY TAPPING BLUE PINE
(PINUS WALLICHIANA)

N.K. GULATI, R.R. FERNANDEZ AND P.S. PAYAL,
Minor Forest Products Branch
Forest Research Institute and Colleges, Dehra Dun

Introduction

Turpentine and resin are the two principal products obtained from the distillation of oleo-resin. While turpentine is primarily consumed in perfumery, pharmaceutical and allied industries resin is a necessary component in Paper, Soap, Textile, Paints and Varnish Industries. The present production of oleo-resin in the country falls short of the demand of these industries. During 1977–78 total production of oleo-resin in the country was 56800 tonnes against a demand of approximately 80,000 tonnes. The demand is expected to rise in the coming years. So much so that by 1983–84 it is estimated to be 1,15,000 tonnes. This will further widen the gap between its production and demand. These circumstances command an urgent need to explore ways and means to augment the resin production in the country.

To achieve this objective the first possibility is to improve upon the tapping method whereby resin yield from chir pine *(Pinus roxburghii)*, which to date is the only species among the Indian pines being tapped, could be increased. In this direction some work has already been carried out at the Forest Research Institute and a new method commonly known as 'Rill' method has been developed which not only eliminates damage to the tapped trees but also promises higher yield of resin. Efforts are being made to convince and persuade the Forest Departments to switch over to this new method of tapping. At the same time further studies to improve this method with a view to make it more easily applicable in the forests on large scale are in progress. All the same, since almost all the chir pine areas are being tapped the adoptation of new tapping method will have only limited scope to enhance the production of resin.

The second alternative is tapping of other Indian Pines. Blue pine *(Pinus wallichiana)* is the next commonly occurring pine in India after chir pine. This paper deals with the prospects to tap blue pine.

Prospects to tap Blue Pine

Blue Pine occurs over an area of 2,86,399 ha in the Himalayan forests. The distribution of the area is 16,132 ha in Uttar Pradesh, 88,442 ha in Himachal Pradesh and 1,81,825 ha in Jammu & Kashmir. The turpentine oil obtained from oleo-resin of blue pine, containing 82 to 94% of pinene, is considered to be of superior quality than that of chir pine which contains 30 to 40% pinene. However, its commercial tapping is beset with certain difficulties like comparatively short tapping period, low yield and higher cost of production.

It will be of interest to review here the results of the exeriments, carried out in 1973 and 1974 at Kanasar, for tapping blue pine trees by the traditional "Cup & Lip" method.

Experimental technique

162 blue pine trees of 40 to 65 cms diameter at breast height were selected at Kanasar Range, Chakrata Forest Division during 1972 and allotted to nine different groups, i.e. 18 trees in each group and given the following treatments :

Group No.	Treatment No.	Particulars of treatment
1	T_1	Control–No Chemical treatment
2	T_2	20% mixture of H_2SO_4 & HNO_3 Spray
3	T_3	20% ,, ,, Paste
4	T_4	40% ,, ,, Spray
5	T_5	40% ,, ,, Paste
6	T_6	40% of sulphuric acid Spray
7	T_7	2% 2, 4–D' Aqueous solution of Sodium Salt 2, 4–dichlorophenoxy acetic acid).
8	T_8	2% 2, 4, 5–T' Aqueous solution of 2, 4, 5-Trichlore Phenoxy acetic acid)
9	T_9	2% MCPA (Aqueous solution of 2 methyl 4-chlorophenoxy acetic acid).

After allotting the trees to various treatments tapping was done during 1973 and 1974 tapp ng seasons. Tapping was carried out with French (Cup & Lip) method wherein width of blaze was 10 cm and depth, 1.25 cms. Freshening interval was 7 days and height of each freshening 1 25 cm The stimulants were applied on the freshly cut surface. The resin was collected with each freshening and weighed to the nearest gramme. The resin yield data was tabulated and average yield per tree per season was calculated. The yield figures for the years 1973 and 1974 are given below in Table 1.

Results of Statistical analysis : 1973 experiment

Very highly significant differences are observed between different treatments in producing the resin yield.

The treatment T (2% spray 2, 4–D) is found to give maximum resin yield (2.28 kg) per tree followed by the treatments T_8 (2% spray 2, 4, 5–T) and T_9 (2% spray MCPA) yielding 2.17 kg and 2.10 kg of resin respectively. The treatments T_4, T_5 and T_6 are however producing lesser resin yield than the control.

Table 1

Resin yield (April–Nov., 1973) in Grammes

	Control	20% Mixture HNO_3+ H_2SO_4	20% Paste H_2SO_4+ HNO_3	40% Spray H_2SO_4+ HNO_3	40% Paste H_2SO_4 HNO_3	40% Spray H_2SO_4	2% Spray 2, 4–D	2% Spray 2, 4, 5–T	2% Spray MCPA.
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9
Total yield of 18 trees.	29407	32109	30806	25382	28296	23887	41009	39037	37876
Yield per tree	1633.7	1783.8	1711.4	1410.1	1566.4	1327.0	2278.3	2168.7	2104.2
%	100	109.1	104.8	86.3	85.9	81.2	138.5	132.7	128 8

Resin yield (May–October, 1974) in Grammes

	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9
Total yield of 18 trees	15676	17091	15903	16782	17992	15234	21278	19813	24057
Yield per tree	870.9	949.5	883.5	932.3	999.9	846.3	1182.1	1100.7	1336.5
%	100	109.0	101.4	107.1	114.8	97.2	135.7	126.4	153.5

1974 experiment

The treatments are found to differ very highly significantly in producing resin yield per tree.

The treatment T_9 (2% spray MCPA) is found to be most effective followed by the treatments T_7 (2% spray 2, 4-D) and T_8 (2% spray 2, 4, 5-T) yielding 1.34, 1.18 and 1.10 kg resin per tree respectively.

The treatments T_3 and T_6 are found to be as effective as control.

The bar diagram are as follows (1973 Expt.)

T_7	$\overline{T_8 \quad T_9}$	T_2	T_3	$\overline{T_1 \quad T_5}$		$\overline{T_4 \quad T_6}$
						(1974 Expt.)
T_9	$\overline{T_7 \quad T_8}$		$\overline{T_5 \quad T_2 \quad T_4}$			$\overline{T_3 \quad T_1 \quad T_6}$

Conclusions

The aforesaid results may not provide sufficient grounds to start tapping of blue pine on large scale and need further investigations but they do hold a promise to go in for it in the coming years. They do reveal that by application of suitable stimulants resin tapping season of blue pine can be prolonged. They also reveal that a per tree yield of 2-10 to 2.28 kg resin when tapped for eight months can be obtained from blue pine trees which is definitely a economically viable proposition keeping in view the higher contents of pinene in kail oleo-resin which increase its value over the oleoresin from chir pine.

Uptill now we could afford to put off giving blue pine tapping a serious trial because we were somehow meeting our demand of resin from the production within the country but with its ever increasing demand it is apparent that we must now start tapping blue pine least we are compelled to import it from other countries. To start with, tapping of blue pine can be started on limited scale in various regions and solutions to operational dfficulties, which we come across, are found before it is introduced on larger areas.

Acknowledgement

The authors are grateful to Officer-in-Charge, Statistical Branch for the analysis of the data of the experiment.

SUMMARY

Results of experiments in the tapping of Blue pine, carried out at Kanasar in Chakrata Division have revealed that application of stimulants like 2, 4-D, 2, 4, 5-T and MCPA prolong the tapping period and thereby increases the resin yield. Trees tapped for full tapping season i.e. April to November yielded 2.1 to 2.28 kg oleo-resin per tree which is definitely an economically viable proposition especially keeping in view the higher pinene contents in the turpentine oil obtained from blue pine oleo-resin which increases its value.

कैल पाइनस वालिशियाना का टिपान करके लीसा उत्पादन में वृद्धि करना

लेखक एन०के० गुलाटी, आर०आर० फर्नेण्डिस व पी०एस० पयाल

सारांश

चकरौता वन मण्डल में कनासर में कैल पर किये गये संपरीक्षणों के परिणामों से पता चला है कि 2, 4-डी, 2, 4, 5-टी० और एम सी पी ए जैसे उत्प्रेरक उपयोग करने टिपान अवधि बढ़ जाती है और फलस्वरूप लीसा उत्पादन में भी वृद्धि होती है। टिपान की पूरी अवधि अर्थात अप्रैल से नवम्बर तक च्यावित वृक्षों से 2.1 से 2.28 किग्रा० तैलीय लीसा प्रति वृक्ष प्राप्त हुआ जो निश्चय ही अर्थशास्त्रीय दृष्टि से सशक्त प्रस्थापना है विशेषकर यह बात ध्यान में रखने पर कि कैल के तैलीय लीसे से निकाले गए तारपीन तेल में पाइनीन तत्व अधिक होता है, जिससे इसका मूल्य और भी अधिक हो जाता है।

———

HIMACHAL PRADESH STATE FOREST CORPORATION LTD.

KANWAR NIWAS, NEW LAND ESTATE, SIMLA—171001

(A H.P. GOVERNMENT UNDERTAKING)

Manufacturers of :—HIMROSIN (ISI), TURPENTINE, PHENYLE & VARNISH EXPORTERS OF HIMROSIN

Suppliers of : PULP, CHARCOAL, FUEL-WOOD & HIGH QUALITY WATER-BORNE TIMBER—**Logs, Sleepers, Scants & Hakaries,** of DEODAR, KAIL, SPRUCE, CHIL, SAL, SAIN & KOKATH

NATIONALIZATION OF FOREST WORKING IN HIMACHAL IS OUR AIM AND WE HAVE ACHIEVED :

* Production of high quality Rosin (ISI marked), Turpentine oil, Varnishes & Phenyle in our modern factories at Nahan and Bilaspur.
* Complete nationalization of resin tapping in Himachal.
* Total purchase of resin extracted from pine trees in Privately owned areas at Rs 450/- per qtl. (Net Weight) at Road Head Depots
* Timber extraction works being carried out in 19 Forest Divisions. The remaining Forest Divisions are being taken over during 1983-84, thereby achieving target of Complete Nationalization of Timber Trade in Himachal Pradesh.
* Scientific exploitation, economic harvesting and maximum utilization of Forest Resources in the State
* Social Justice to Forest Workers.
* Increased employment in the setting up and development of forest based industries in Himachal Pradesh through our HIMKASHTH Sale Depots at Parwanoo, Bilaspur, Mantaruwala (Paonta-Sahib), Badyala (Una), Mahadev (Sundernagar) and Bhadroya (Damtal-Nurpur).
* Bulk supply of "Goltus" at Rs. 220/- Dim-and-Dimas at Rs. 270/- per cum to the Saw Millers on road head depots for the manufacture of Fruit Packing Cases in the main apple zone of the state during 1982 season.
* Purchase of trees of private Forests at attractive rates.

A.K. Mukerji, I.F.S.
Managing Director

Sujan Singh Pathania
Vice-Chairman

Devi Singh
(Forest Minister) Chairman

FOREST VEGETATION SURVEY AND CLASSIFICATION WITH SPECIAL REFERENCE TO SOUTH INDIA

I. VEGETATION SURVEY AND QUADRAT ANALYSIS

S.K. SHARMA, M. GEORGE AND K.G. PRASAD

Forest Soil-cum-Vegetation Survey,
Southern Region, Coimbatore (Tamil Nadu)

Introduction

Various attempts have been made in other countries (Beard, 1955; Brown, 1954; Cottam and Curtis, 1949; Dansereau, 1951; Disc and Butler, 1960) to study the floristic composition of different forest types and most of the vegetation data were collected through samplings from representative sites. The sampling units were standardised to suit the purpose, nature of vegetation, climate, availability of men, material, time, etc. In India also studies were carried out to optimise sizes of sampling unit and methodology to be adopted for various ecological studies (Misra and Puri 1957; Puri, 1959; Puri and Gupta, 1951; Waheed Khan, 1953; 1958; 1961; and Waheed Khan and Gupta, 1960). The quadrat size and methodology recommended by the Indian authors were tried in South Indian forests but found quite difficult to follow due to various limitations. Therefore, data were collected from southern tropical dry deciduous forest, (5AC3), moist deciduous forests, (3BC2), semi-evergreen forests (2AC2), and evergreen forests (1AC4) (Champion and Seth, 1968) for standardising the minimal area for quadrat analysis. Present paper deals with the standardisation of quadrat size and methodology and laying out quadrat for speedy and convenient collection of vegetation data for the purpose of vegetation classification and mapping.

Materials and methods

Standardisation of quadrat size. Minimal area of the quadrat is defined as the smallest area in which species composition of the vegetation under study is fairly represented (Dombois and Ellenberg, 1974). In the present study minimal area was determined by laying out a small quadrat and subsequently the quadrat size was enlarged to twice the size then to four times, eight times and so on (Fig. 1). The additionally occurring species were listed separately for each enlarged quadrat and the quadrat size was increased until the species added to the list become very few (Table 1 and 2).

Table 1

Species recognised from moist deciduous forest (Pterocarpus – Grewia community) for determining minimal area of tree quadrat

Quadrat		Additional species recognised		Cumulative total of species
Size (m)	Area (m^2)	Name	Number	
2 × 2	4	Nil	0	0
2 × 4	8	*Baubenia malabarica*	1	1
4 × 4	16	*Emblica officinale*	1	2
4 × 8	32	*Delbergia paniculata*	1	3
8 × 8	64	*Bridelia retusa* *Terminalia ballerica* *Anogeissus latifolia*	3	6
8 × 16	128	*Albizzia odoratissima* *Careya arborea* *Pterocarpus marsupium* *Albissia lebeck*	4	10
16 × 16	256	*Legerstroemia lanceolata* *Santalum album* *Dalbergia latifolia* *Azzadaricta indica*	4	14
16 × 32	512	*Terminalia tomentosa* *Grewia tiliaefolia* *Premna tomentosa* *Bombax cieba,*	4	18
32 × 32	1024	*Tectona grandis*	1	19
32 × 64	2048	Nil	0	19

Table 2

Species recognised from moist deciduous forest for determining minimal area of shrubs quadrat

Quadrat		Additional species recognised		Cumulative total of species
Size (m)	Area (m²)	Name	Number	
1 × 1	1	*Pavetta indica* *Mundulea sericea* *Helecteres isora* *Carissa carandas*	4	4
1 × 2	2	*Atalantia monophylla* *Eupotorium glandulosum*	2	6
2 × 2	4	*Lantana camera* *Acalypha fruticosa* *Glycosmis pentaphylla*	3	9
2 × 4	8	*Strobilantlus* sp. *Chomelia* sp. *Terilobium indicum* *Randia dumetorum* *Fluggea leucopyrus*	5	14
4 × 4	16	*Grewia* sp. *Corchorus* sp. *Acasia intsia*	3	17
4 × 8	32	Nil	0	17

In order to determine minimal area of the quadrat, species number was plotted against quadrat area and a curve was drawn which resulted in species area curve (Fig. 2). Cain (1938) pointed out that species area is affected by the ratio of y to x and suggested, using the point along the curve at which an increase in 10% of the total sample area yields only 10% more species. Accordingly, line a_1 was drawn Line a_2 was drawn paralel to line a_1 and tangential to species area curve. Minimal quadrat area was obtained by protracting line a_3 from intersecting point on species area curve to the x axis. This procedure was adopted for dry deciduous, moist deciduous, semi-evergreen and evergreen type of forest and the minimal area was arrived at for trees and shrubs quadrats. The minimal area thus arrived at was rounded off to the nearest higher value and is given in Table 3 (Fig. 2 to 9).

Table 3

Optimum size of quadrat for different types of forests in South India

Forest type	Trees quadrat		Shrubs quadrat	
	Size (m)	Area (m^2)	Size (m)	Area (m^2)
Moist deciduous	20 × 20	400	3 × 3	9
Dry deciduous	20 × 20	400	3 × 3	9
Evergreen	30 × 30	900	3 × 3	9
Semi-evergreen	30 × 30	900	3 × 3	9

Lay out of quadrats and recording vegetation data. After arriving at the size of the quadrats, representative site was selected for detailed quadrat analysis taking into consideration various factors like floristics, topography, drainage, soil etc.

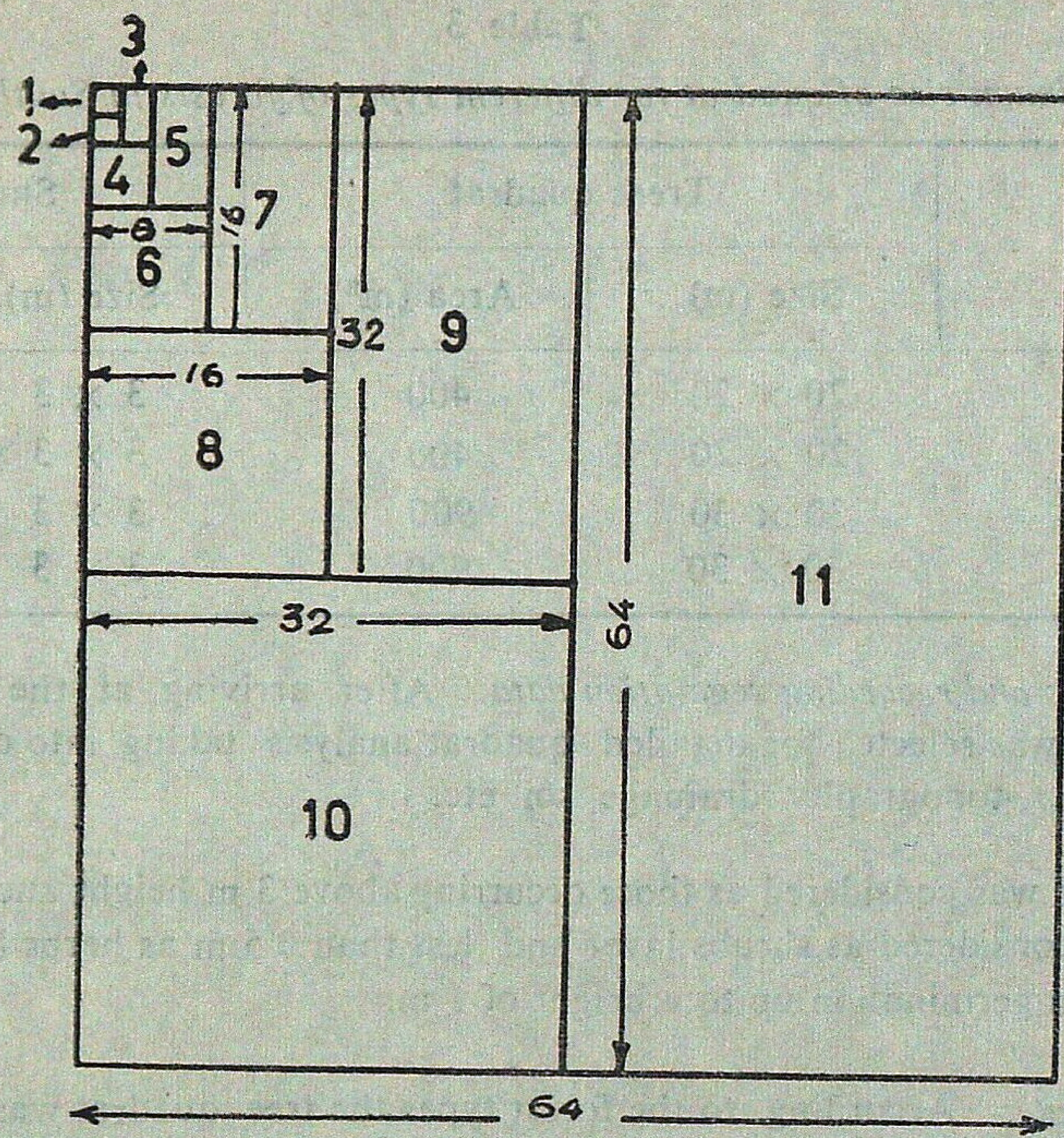
A tree layer was considered as those occurring above 3 m height and, between 3 m and 0.5 m height was considered as shrubs layer and less than 0.5 m as herbs layer. Seedling was considered as from germination up to a height of 1 m.

Tree quadrat : According to the forest types the tree quadrat was laid out and all the tree species were noted storey wise. The number of trees in each species in each storey were then counted and recorded along with their girth at breast height (g.b.h). Though, it is advisable to measure the height of all trees within the quadrat, in practice it is not always possible to measure accurately the height of all trees in the forests. Therefore, average height of the storey was recorded.

Shrub quadrat : After recording all the data pertaining to the trees in the trees quadrat, the shrubs quadrat was laid out within the trees quadrat at one corner in such a manner that, a portion of the two sides of the tree quadrat form the sides of the shrub quadrat (Fig 10). All the shrub species in this quadrat were noted and the total number of individuals in each species were counted and recorded.

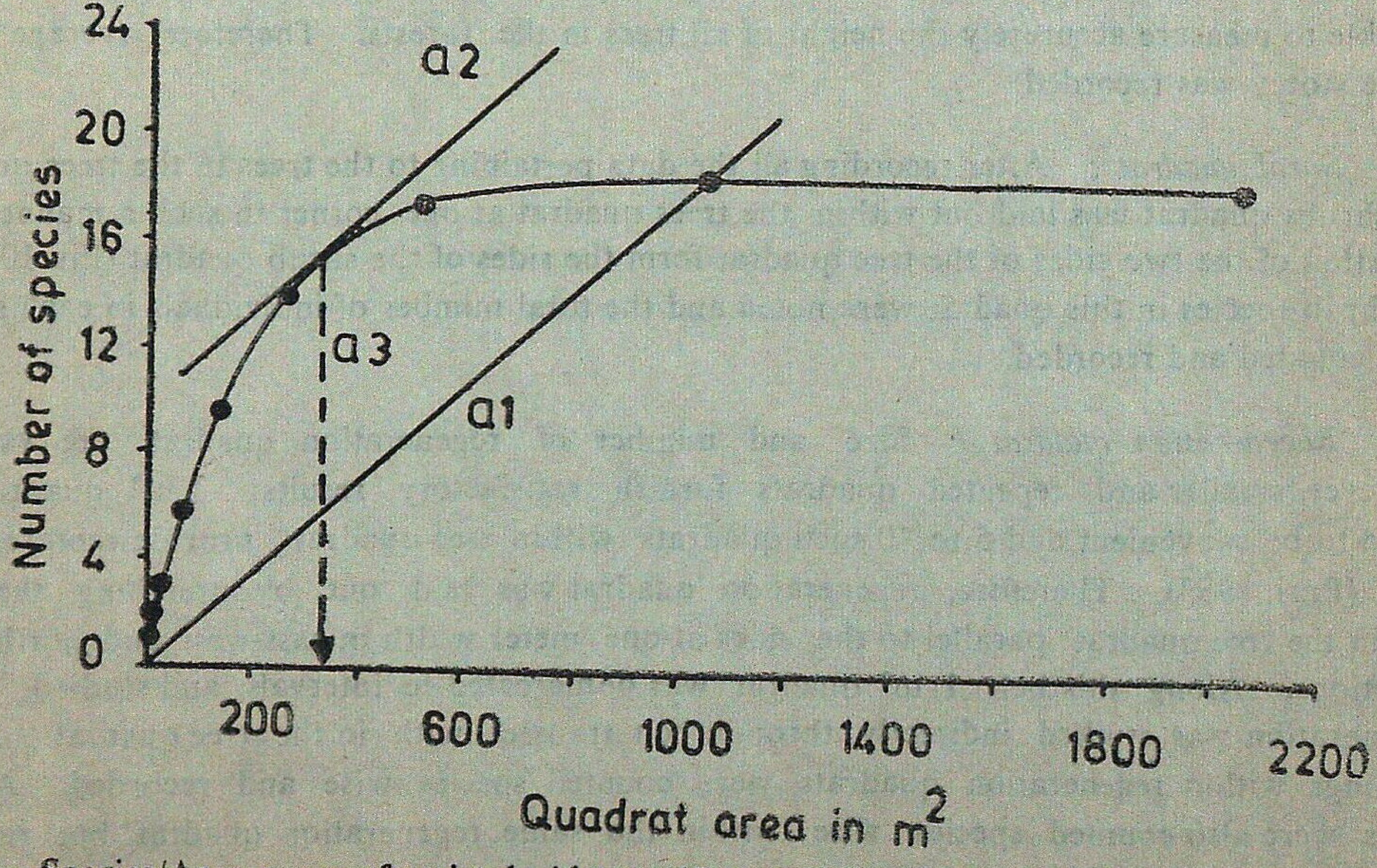
Regeneration quadrat : Size and number of regeneration quadrat are variable. However, smaller and repeated quadrats furnish satisfactory results. 1 m^2 quadrat was found to be convenient and 5 to 10 such quadrats within tree quadrat provide representative data (Puri, 1953). Therefore, regeneration quadrat was laid out by stretching the tape within the tree quadrat parallel to the sides at one meter width in east-west and north-south directions. Along this belt 1 m^2 quadrat was demarcated in intervals and studied. Thus, regeneration was studied indirectly through belt transect with in the tree quadrat. All the seedlings within regeneration quadrats were counted species wise and recorded. All the herbs were also counted species wise within the same regeneration quadrat but recorded separately.

Fig. 1



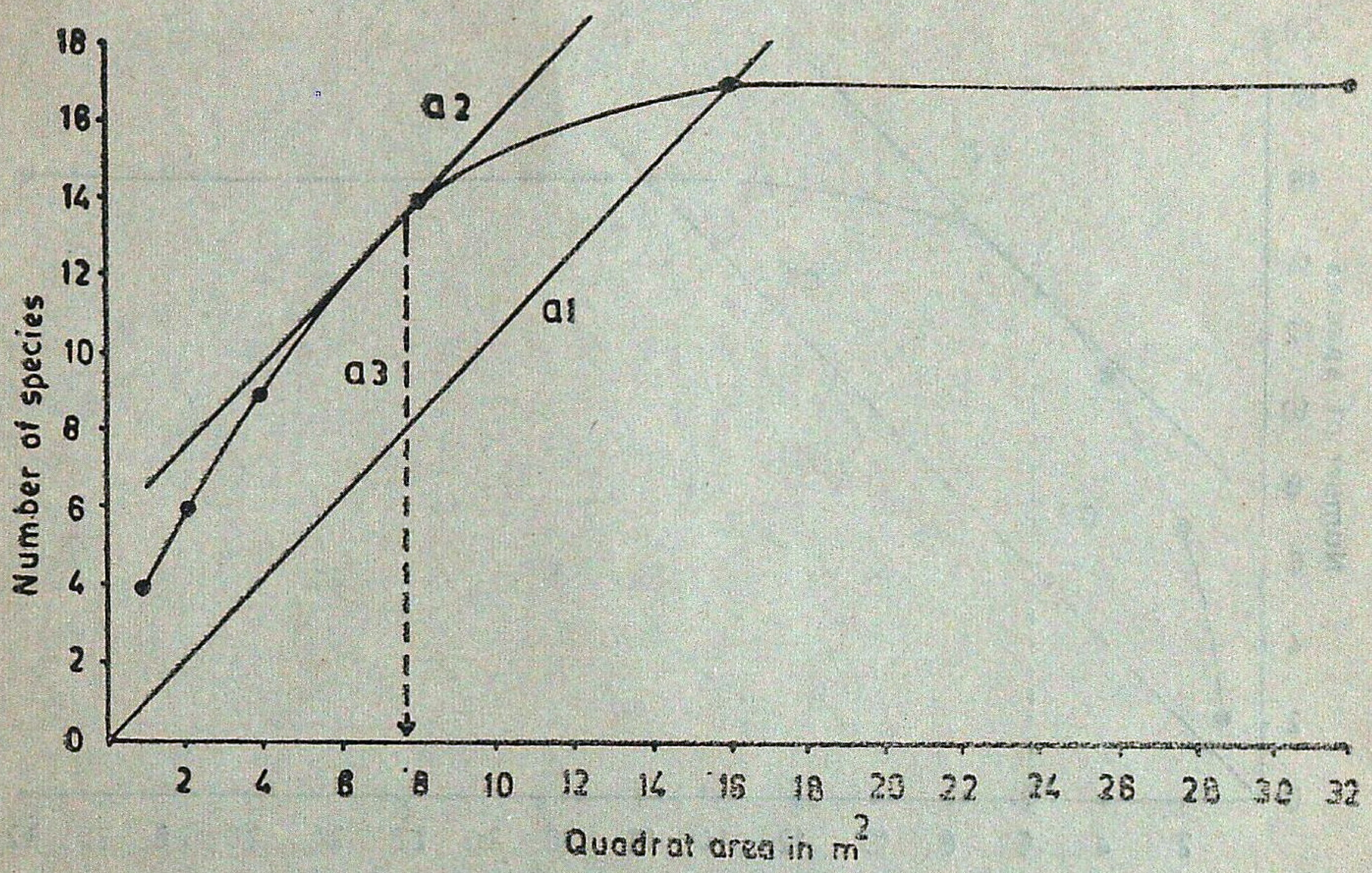
Nested plots for determining the minimal quadrat area

Fig. 2



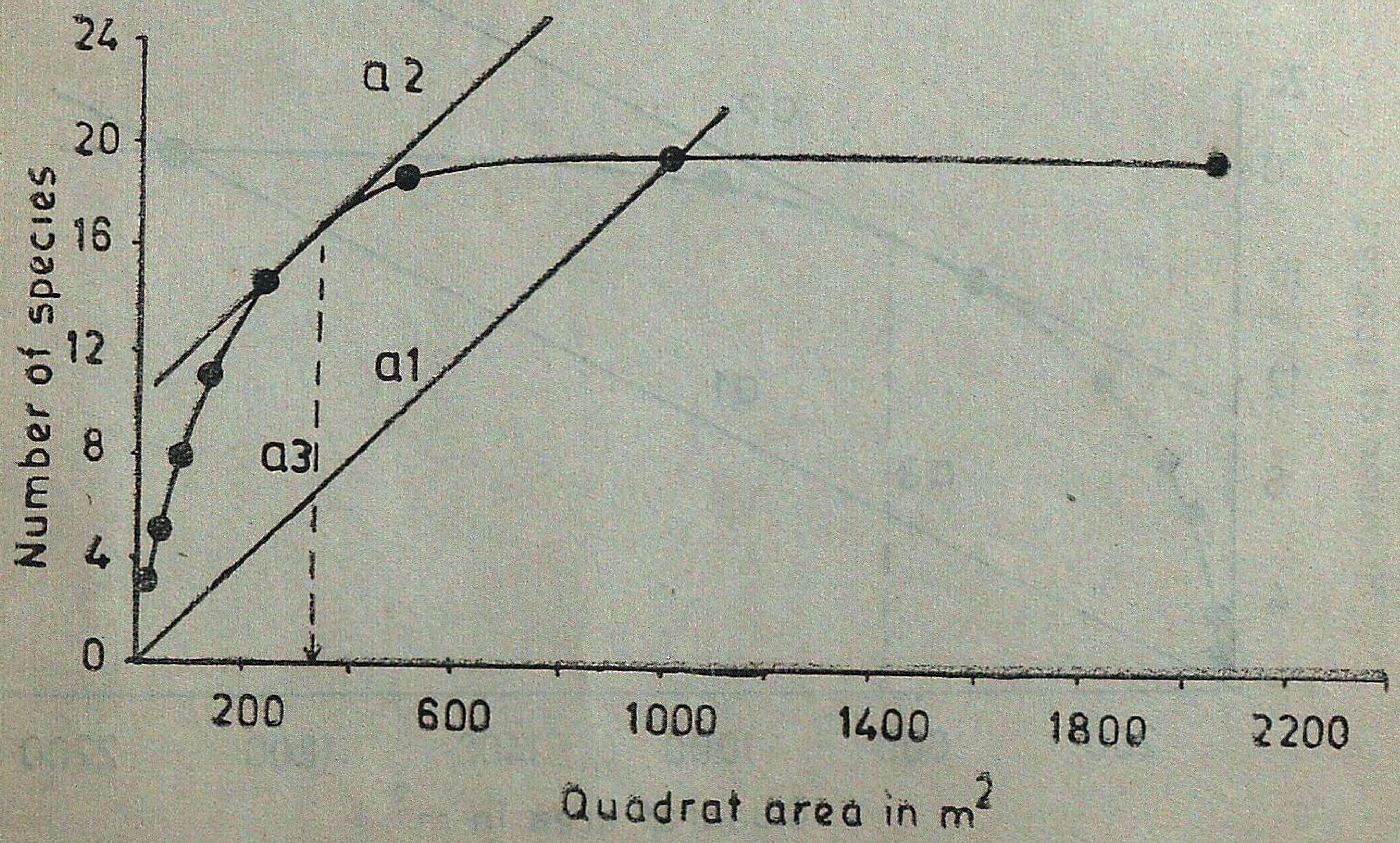
Species/Area curve of moist deciduous (*Pterocarpus–Grewia* community) forests

Fig. 3



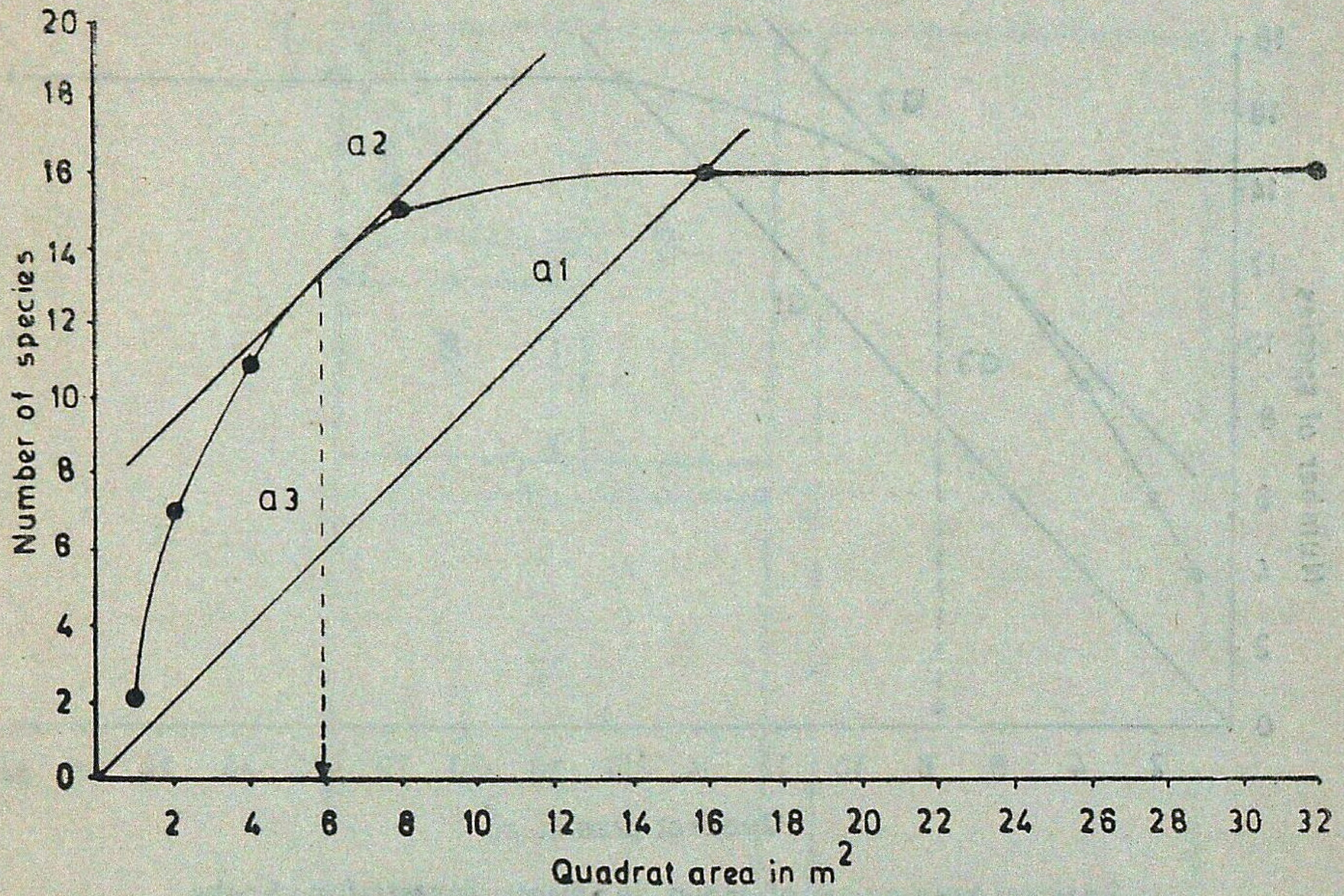
Species/Area curve of moist deciduous forests for shrubs

Fig. 4



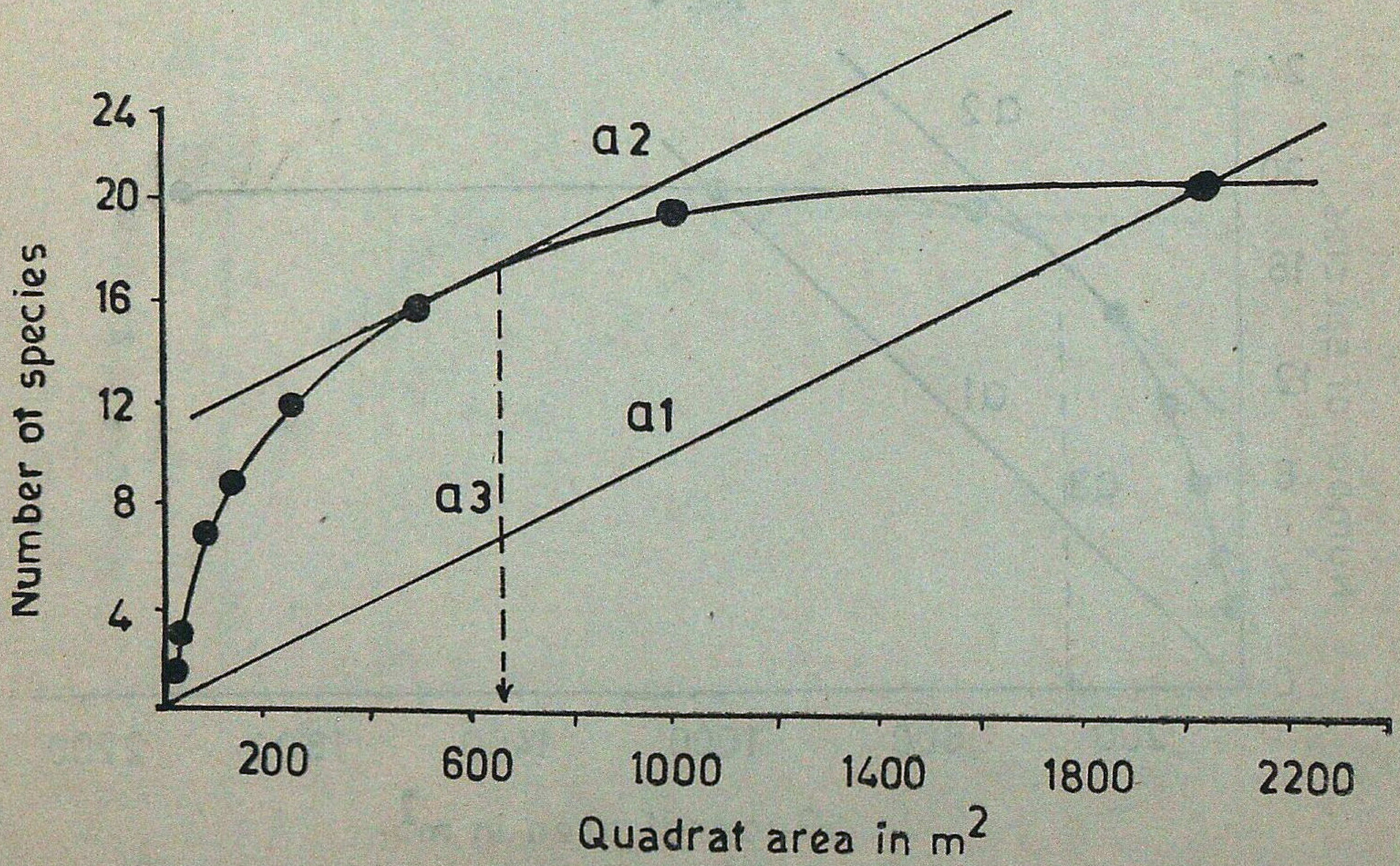
Species/Area curve of dry deciduous (*Albizzia–Givottia* community) forests

Fig, 5



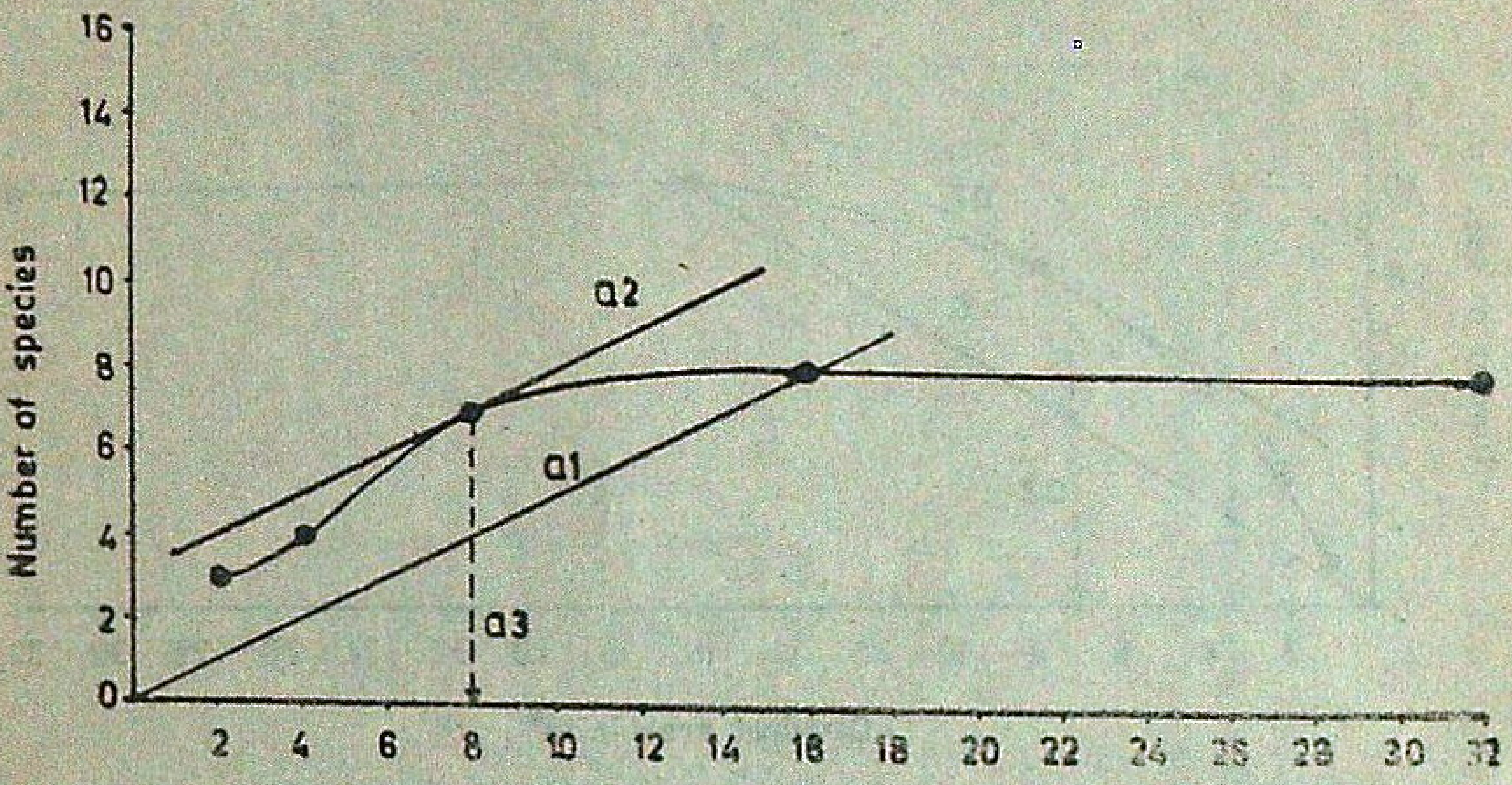
Species/Area curve of dry deciduous forests for shrubs

Fig. 6



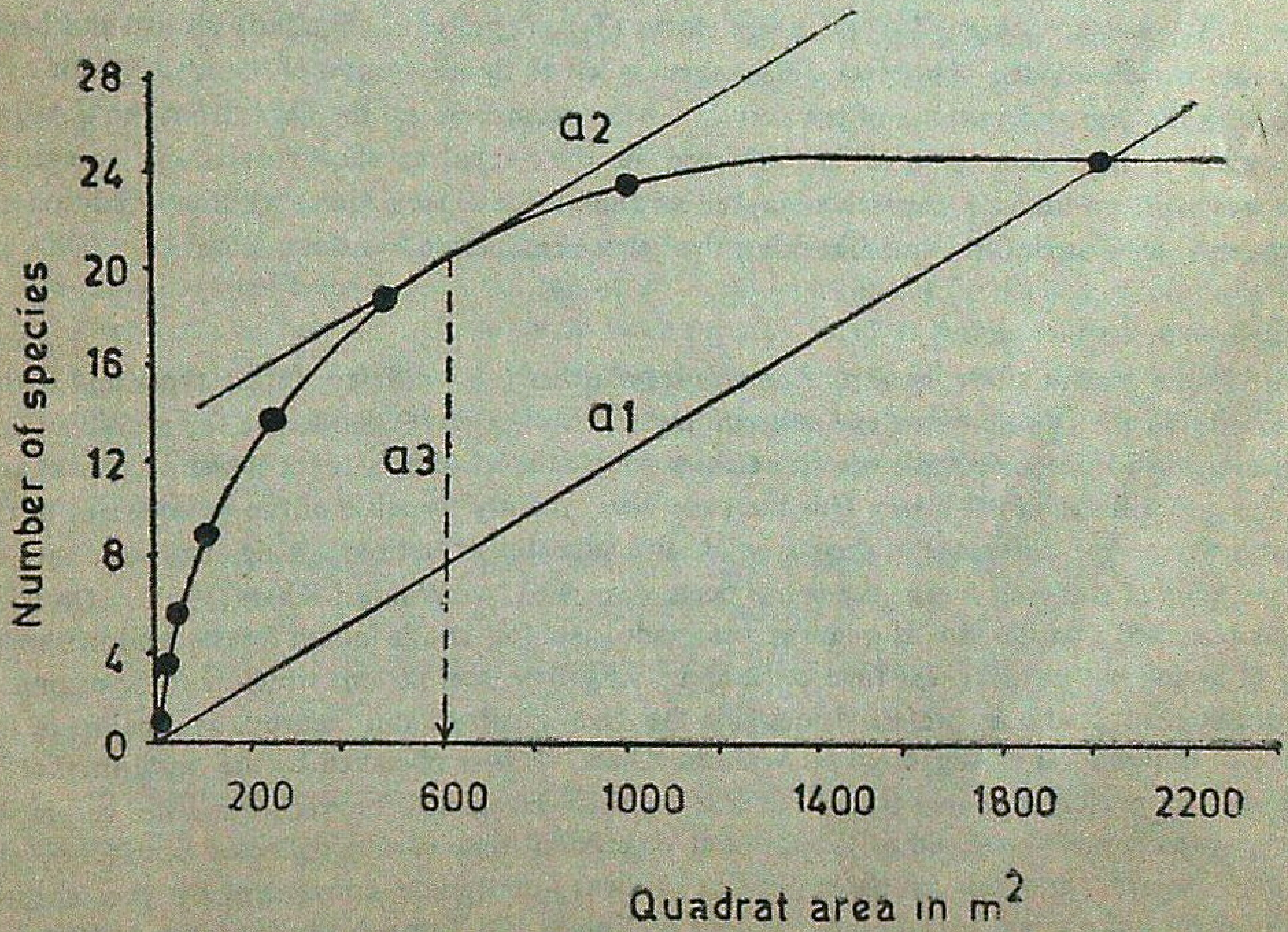
cies/Area curve of evergreen (*Palaquium-Cullenia* community) forests

Fig. 7



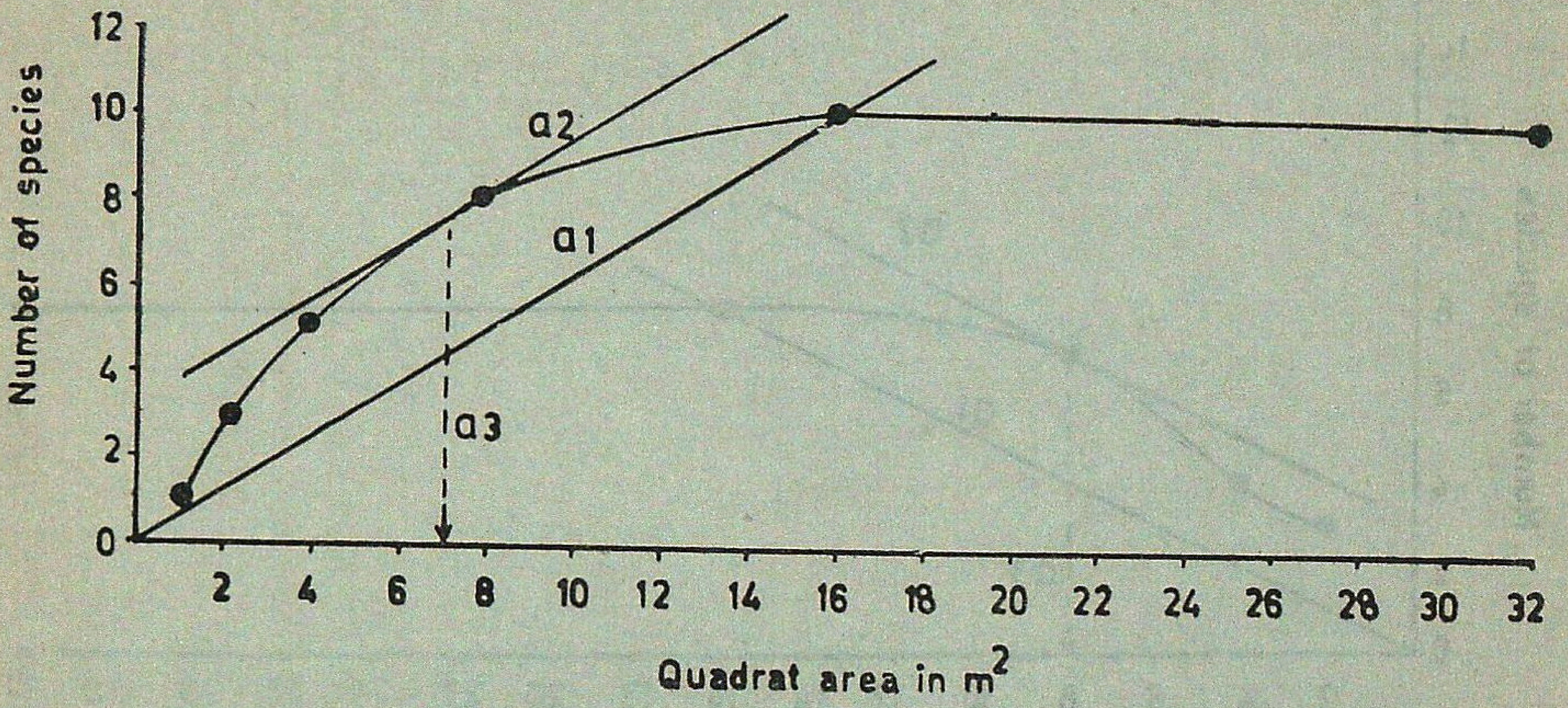
Species/Area curve of evergreen forests for shrubs

Fig 8



Species/Area curve of semi-evergreen (*Elaeocarpus–Eugenia* community) forests

Fig. 9



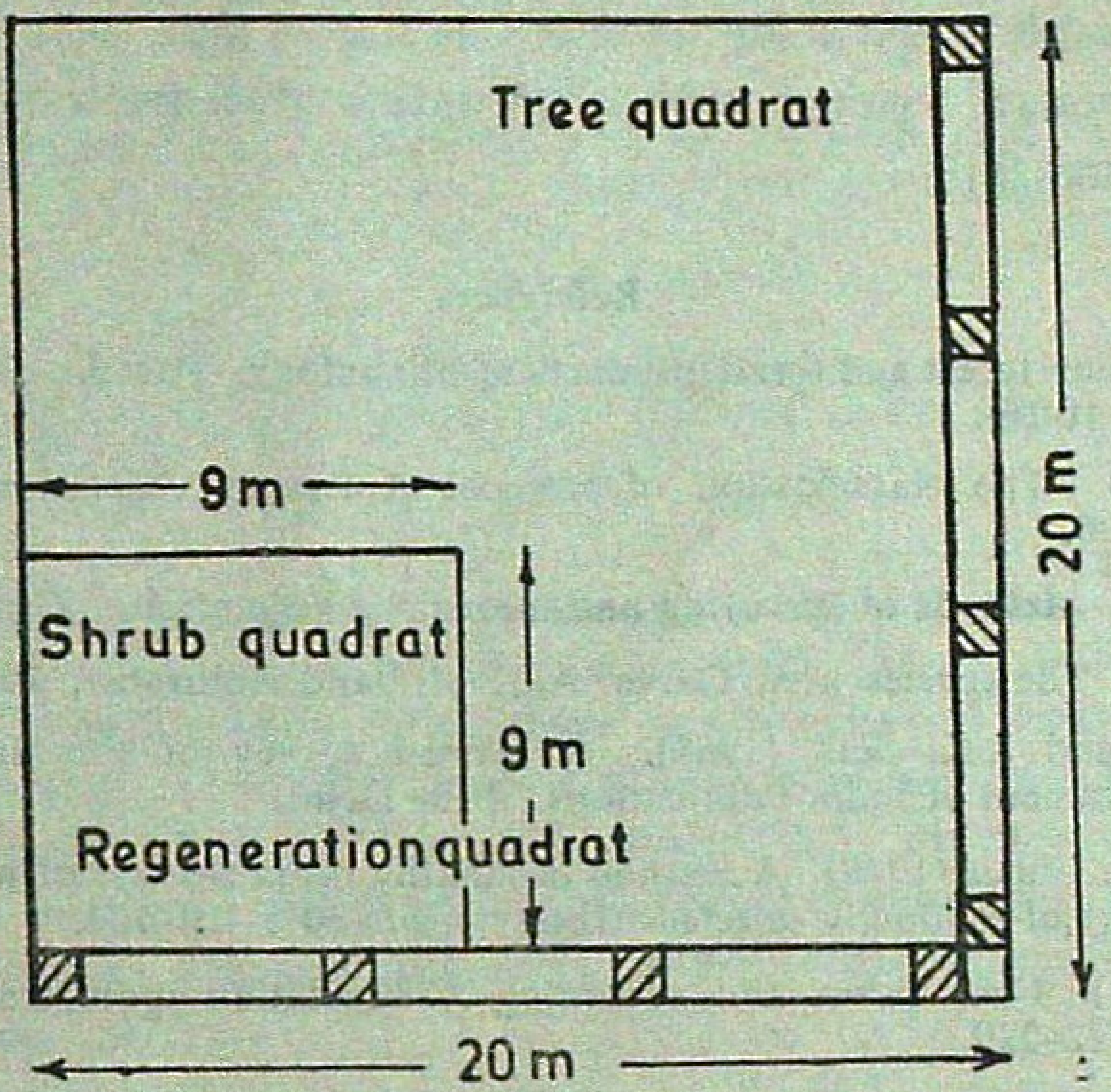
Species/Area curve of semi-evergreen forests for shrubs

Though there is no hard and fast criteria for demarking the stories, as it varies according to the forest type, it is always desirable to record the data storey wise as suggested by Anon (1960) and Dombois and Ellenberg (1974). The tree layers may be sub-divided into first storey (T_1), second storey (T_2) and third storey (T_3); if present. Similarly shrubs and herbs may also be sub-divided. However, this aspect is left to the discretion of the investigator as it goes with the aim and purpose of the survey. After recording all the data from the quadrat, invariably a field note is also incorporated in the quadrat sheet pertaining to various obserrvations on both quantitative as well as qualitative aspects along with any additionally occuring species around the quadrat other than those enumerated in the quadrat.

Discussion and conclusion

In the present study, quadrat size was standardised for different forest types and it was observed that the minimal area varies according to forest types. Quadrat size for evergreen and semi-evergreen forests (900 m^2) was more than double the quadrat size for moist deciduous and dry deciduous forests (400 m^2). This increase was mainly because of the greater size of the trees as well as the difference in their spacial and lateral distribution. A detailed account on the methods of studying forest types has been described by Waheed Khan (1961). On trial, it was observed that the size of quadrat was inadequate for south Indian forests and methodology of laying out quadrat was time consuming. Further, soil pedon which is to be examined for pedological study, is preferred out side the tree quadrat, but nearby, as against in the centre of the quadrat as suggested by Waheed Khan. It was observed by the authors that by exposing the profile adjoining to the quadrat the time consumed for recording the vegetation data is considerably reduced as the soil and vegetation data can be collected simultaneously. Laying out of quadrats as shown in Fig. 10 was found more convenient by the authors during their survey work in forest divisions of Kerala and Tamil Nadu (Sharma and Prasad, 1982) for vegetation classification and mapping.

Fig. 10



Lay-out of quadrats for vegetation analysis in moist deciduous forests
The quadrat size varies according to forest types

SUMMARY

The paper deals with the standardisation of quadrat size and recording of vegetation data with special reference to south Indian forests for its classification into communities and mapping. The data were collected from south Indian dry deciduous, moist deciduous, semi-evergreen and evergreen type of forests. The minimal area for tree quadrat depends on the forest type and varies from 400 m² for dry and moist deciduous forests to 900 m². For semi-evergreen and evergreen forests. Quadrat size of 9 m² was minimal for shurbs irrespective of forests types. Methods of laying out quadrat for convenient and speedy recording of vegetation data have been described.

वनों की वनस्पतियों का सर्वेक्षण तथा दक्षिण भारत के विशेष सन्दर्भ में उनका वर्गीकरण/
वनस्पति सर्वेक्षण तथा चतुष्कोण विश्लेषण

लेखक एस०के० शर्मा, एम० जार्ज व के०जी० प्रसाद

सारांश

प्रस्तुत अभिपत्र चतुष्कोण आकार को प्रतिमानित करने तथा वनस्पतियों को आलिखित करने विशेषकर दक्षिण भारत के वनों के संदर्भ में उन्हें पादप समुदायों और मानचित्र बनाने के लिये वर्गीकृत करने की विवेचना से सम्बन्धित है। इसके आंकड़े दक्षिण भारत शुष्क पर्णपाति, आर्द्र पर्णपाति, अर्द्ध सदाहरित और सदाहरित प्रकार के वनों से इकट्ठे किये गये। वृक्ष चतुष्कोण का न्यूनतम क्षेत्र वन प्ररूप पर निर्भर है और शुष्क

और आद्र पर्णपाती वनों के लिये 400 वर्ग मीटर से लगा कर अर्द्ध सदाहरित और सदाहरित वनों के लिये 900 वर्ग मीटर तक हो सकता है। क्षुपों के लिए चतुष्कोणक आकार 9 वर्ग मीटर न्यूनतम रहा, वन प्ररूप चाहे कोई भी क्यों न हो। सुविधाप्रद चतुष्कोणक बनाने और वनस्पति के आंकड़े शीघ्र आलेखित करने की रीतियों का वर्णन भी इसमें दिया गया है।

References

Anon (1960). Indian forest and forest products terminonlogy. Part I. *Ind. For. Rec*; (N.S.) Silv. 10 (6).

Beard, J.S. (1955). The classification of tropical American vegetation types. *Ecol.* **36** : 89–100.

Brown, D. (1954). Methods of surveying and measuring vegetation. *Commn. Agri Bull.* **42**

Cain, S.A. (1938). The species–area Curve. Am. Midland Naturalist, **19** : 573–581.

Champion, H G and S.K. Seth (1968). A revised survey of the forest types of India. Government of India Publications. New Delhi.

Cottam, G. and J.T. Curtis (1949). A method of making rapid surveys of woodlands by means of pairs of randomly selected trees. *Ecol.* **30** : 101-104.

Dansereau, P. (1951) Description and recording of vegetation upon structural basis. *Ecol.* **32** : 172–229.

Disc, R.L. and J.E Butler (1960). A phytosociological study of small prairie in Wisconsin. *Ecol.* **41** : 316-327.

Dombois, D.M. and H. Ellenberg (1974). Aims and methods of vegetation ecology, John Wiley and Sons, New York.

Misra, R and G.S. Puri (1955). *Indian manual of plant ecology.* Oxford Book Co., New Delhi.

Puri, G.S. (1959). Soil pH and forest communities in the sal *(Shorea robusta)* forests of the Dehra Dun valley, U P. *India. Ibid.* **16** : 292–309.

Puri, G.S. and A.C. Gupta (1951). The Himalayan conifers II. The ecology of humus in conifer forests of the Kulu Himalayas. *Ind. For.*, **77** (1) : 55-63.

Sharma, S.K. and K.G. Prasad (1982). (Edited) Forest Soil vegetation Survey report on Gudalur Forest Division, Tamil Nadu. F.R.I. & Colleges, Dehra Dun.

Waheed Khan, M.A. (1953). South Raipur sal forests and its ecological study with special references to its management. *Ind. For.*, **79** (3) : 184–191.

Waheed Khan, M.A, (1958). Sampling unit in phytosociological studies. *Ind. For.*, **84** (11) : 651-663.

Waheed Khan, M.A. (1961). Ecological studies in Indian forests. Methods of studying forest types. *Proc. Tenth Silv. Conf.* F.R.I. Dehra Dun.

Waheed Khan. M.A. and A.C. Gupta (1960). Plant communities associated with sal *(Shorea robnsta)* regeneration in Dehra Dun valley *Ind. For*, **867** : 417–422.

A NOTE ON PHYSICAL AND MECHANICAL PROPERTIES OF *ACACIA MEARNSII* (SYN. *ACACIA MOLLISSIMA*) FROM TAMIL NADU

V.K. GUPTA AND M.C. KUKRETI

Timber Mechanics Branch,
Forest Research Institute and Colleges, Dehra Dun

Introduction

Acacia mearnsii is one of the three Australian wattles namely *A. dealbatat*, *A. decurrens* and *A. mearnsii* (Syn. *A. mollissima*) which were originally introduced in Nilgiris (Tamil Nadu) in the middle of last century. These have now become completely naturalised in this area (Rao and Purkayastha, 1972). The sapwood of this species is white to light whitish yellow gradually merging into the pinkish or light red heartwood (Rao and Purkayastha, 1972). The wood is said to be a good raw material for the manufacture of paper, boards and rayon. The bark has a high percentage of tannin and is one of the best raw material for tanning leather (Rao and Purkayastha, 1972).

As no data of its physical and mechanical properties were available it was considered necessary to undertake full scale tests to evaluate its physical and mechanical properties and to examine its suitability for various end-uses.

Material and testing

10 logs of *Acacia mearnsii*, about 2.75 m in length and about 53 cm in girth were received from Madurai North Division Tamil Nadu. The logs were taken out from different trees. The trees were from natural seedling and of 10 m on the average in height. The logs were crooked and had unsound Central portion. Thus only six logs were considered suitable for testing.

These logs were converted into scantlings of 2.65 × 2.65 cm in cross-section which were finished into 2.5 × 2.5 cm before testing. The layout and conversion of the material into scantlings was done in the same way as for standard size 5 × 5 cm cross-section given in IS : 2455–1974 (I.S.I., 1974). The smaller cross-section was chosen because of the small girth of the logs. The scantlings were cut into two parts of about 1.3 m length. All the even numbered scantlings from the upper half and old number scantlings from the lower half of each log were taken for testing in green condition. Out of the remaining material the material of 5 logs was tested after "Kiln drying" as the material of one log was not found suitable for testing after kiln drying. The tests specimens for different tests were taken out from scantlings of different lots as per schedule given in IS : 2455–1974. Physical and mechanical tests were done on the clear specimens selected as above in accordance with the procedure followed for specimens of 5 × 5 cm cross-section and given in IS : 1708–1969 (I.S.I., 1969).

Presentation of data

The results of the tests carried out in green and kiln-dry conditions are given in Table 1. The average values of the properties are given in column 2 and 8 for green and kiln-dry condition respectively. Minimum and maximum value in green condition have also been reported in col. 3 and 4. The standard deviation based on tree average and coefficient of variation of all the properties in green condition are given in col. 5 and 6. Expected values based on specific gravity strength relationship (Sekhar and Rawat, 1959) in green condition are reported in col. 7. In col. 9 improvement factor i.e. percentage change in values of various properties from green to kiln-dry condition is given. For purpose of comparison of the strength properties of this species with Teak the average values of standard Teak (From Malabar, Nilambur and Coimbatore) are given in col. 10 and 11 in green and kiln-dry condition.

In Table 2 safe working stresses of this species for Standard Grade (Sekhar & Rajput, 1972) are reported alongwith that of Teak. Table 3 gives the tentative comparative suitability indices calculated from green and kiln-dry strength values with respect to Teak taken as 100 as per usual procedures (Sekhar & Gulati, 1972).

For comparison some properties of *Acacia mearnsii* from South-East Asia & Ocenia (Chudnoff, 1980) have been reproduced in Table 4.

Discussions

On comparing of the green values of this species with corresponding values of Teak (Col. 2 and 10) in Table 1 it is observed that all the properties of this species are lower than Teak. In kiln-dry condition also the properties of this species are lower than Teak except "Work to elastic limit", "compressive strees at E.L.", "Hardness (Radial)" and "Shear (Tangential)".

It may be seen from col. 9 of Table 1 that all the properties except "Work to max. load and total work" in static bending tests and "Modulus of elasticity" in tension parallel to grain test have shown considerable improvement from green to kiln-dry condition. On comparing col. 2 and 7 of this table all the observed values except "Work to E.L." and "Work to max. load" in static bending are lower than the values expected from specific gravity strength relationship.

From Tables 2 and 3 it may be noted that safe working stresses and suitabilty indices are lower than Teak. This is also pointed out that according to the M of E and the safe working stresses the species falls under ordinary group for structural use (Sekhar and Rajput, 1972)

According to the standard classification of timbers (Sekhar & Gulati, 1972) *Acacia mearnsii* can be categorised as heavy, weak, not tough and soft timber species. In Australia the timber is said to be used for mining props, flooring blocks and manufacture of hardboards (Farmer, 1972). It may probably be because the timber from native countries have better strength properties (Table 4) than that grown in India.

Table 1

Physical and Mechanical Properties of Acacia mearnsii from Tamil Nadu

Properties	Green condition (Av. m.c. = 62.8%)						Average value in kiln-dry condition (Av. m c. =10.4%)	Improvement factor	*Tectona grandis* (Teak) from Malabar, Nilambur and Coimbatore.	
	Average value	Minimum value	Maximum value	Standard deviation	Coefficient of variation	Expected value			Average value in green condition on (Av. m. c.=76.6%)	Average value in kiln-dry conditon (Av m c. =9.5%)
1	2	3	4	5	6	7	8	9	10	11
(A) *General*										
Specific gravity (Wt oven dry)/(volume of test)	0.549	0.407	0.824	0.055	9.9	—	0.606	7.8	0.596	0.649
Weight in kg/m³ (at an average moistu e content indicated)	894	—	—	—	—	—	669	—	1056	711
(B) *Static bending*										
Fibre stress at elastic limit (kg/cm²)	372	151	566	58.8	15.8	374	550	47.9	509	589
Modulus of rupture (kg/cm²)	518	271	765	65.4	12.6	633	846	63.4	841	1036
Modulus of elasticity (1,000 kg/cm²)	61.0	20.8	109.6	21.2	34.8	91.1	101.1	65.7	109.7	128.5
Work to elastic limit (kg. cm/cm³)	0.134	0.030	0.192	0.032	23.9	0.118	0.223	66.1	0.134	0.158
Work to maximum load (kg cm/cm³)	0.85	0.12	1.96	0.289	34.0	0.58	0.67	-21.3	0.86	0.84
Total work (kg cm/cm³)	1.33	0.56	1.80	0 30	22 6	1.42	0.88	-34.0	1.79	1.80

(Contd..)

1	2	3	4	5	6	7	8	9	10	11
(C) *Impact bending*										
Brittleness test, Izod value (kg/cm²)	102	55	207	33.4	32.8	—	137	34.3	129	—
(D) *Compression parallel to grain*										
Compressive stress at elastic limit (kg/cm²)	200	59	355	93.8	46.9	227	395	97.7	311	333
Maximum crushing stress (kg/cm²)	241	116	432	39.2	16.3	318	470	95.0	415	539
Modulus of elasticity (1,000 kg/cm²)	33.5	13.1	63.3	17.8	53.0	102.0	65.5	95.5	129.8	139.3
(E) *Compression prependicular to grain*										
Compressive stress at elastic limit (kg/cm²)	41	19	65	11.2	27.3	62	87	110.9	89	119
(F) *Hardness* (load to embed 1.128 cm diameter steel ball to half diameter).										
Radial (kg)	309	95	428	109.7	35 5	415	538	74.1	557	499
Tangential (kg)	303	98	413	103.5	34.2	424	534	76.2	551	617
End (kg)	308	90	433	106.4	34.5	431	534	73.4	486	499
(G) *Shear parallel to grain*										
Radial (kg/cm²)	71.2	56.6	89.1	11.7	16.4	74.2	79.0	11.0	89.5	99.5
Tangential (kg/cm²)	79.6	42 9	107.1	19.6	24.6	83 0	118 8	49.3	100 2	113.9
(H) *Tension parallel to grain*										
Tensile stress at elastic limit (kg/cm²)	443	238	779	241.8	54.6	—	647	46.1	—	—
Maximum Tensile stress (kg/cm²)	727	476	1132	294.0	40.4	—	752	3.4	—	—
Modulus of Elasticity (1,000 kg/cm²)	68.8	48.0	90.3	11.4	16.6	—	52.7	-23.4	—	—

Table 2

Safe working stresses of Acacia mearnsii for standard grade

Property			*Acacia mearnsii*	Teak
Bending and Tension along grain	(a)	Inside location	104	168
Extreme Fibre stress (kg/cm²)	(b)	Outside location	86	140
	(c)	Wet location	69	112
Shear (kg/cm²)	(a)	Horizontal—All locations	8.3	10.4
	(b)	Along grain—All locations	11.8	14.9
Compression parallel to grain	(a)	Inside location	60	104
	(b)	Outside location	54	92
Extreme Fibre stress (kg/cm²)	(c)	Wet location	44	75
Compression perpendicular to grain	(a)	Inside location	23	49
Fibre stress at elastic limit (kg/cm²)	(b)	Outside location	18	38
	(c)	Wet location	15	31

Table 3

Comparative suitability indices of Acacia mearnsii with respect to teak taken as 100

Use	Suitability index
Weight	91
Strength as a beam	67
Stiffness as a beam	65
Suitability as a post	73
Shock resisting ability	93
Shear	82
Hardness	69

Table 4

Acacia mearnsii from South-east Asia & Ocenia (3)

Moisture content	Sp. gravity	Bending strength (kg/cm²)	M of E in (100 kg/cm²)	Maximum crushing strength (kg/cm²)	Side hardness kg
Green	0.60	812	113 9	363	581
Air-dry 12%	—	1230	146.2	619	795

SUMMARY

Physical and mechanical properties in green and kiln-dry conditions based upon tests conducted on small clear specimens of *Acacia mearnsii* from Madurai, North Division, Tamil Nadu have been reported. The results so obtained have been compared with *Tectona grandis* (Teak). Estimated values of different properties calculated from strength—specific gravity formulae have been reported and compared with observed values in green condition Safe working stresses and tentative suitability indices have also been reported and compared with the corresponding values of Teak. It has been observed that this species is inferior to Teak. The observed values of this species are also found to be lower than the values expected from strength specific gravity relationship.

तमिलनाडु से प्राप्त अकेसिया मिर्यसिआई पुर्वनाम अकेसिया मोल्लिसीमा के भौतिक
और संधारी गुणों पर एक टिप्पणी

लेखक बी०के० गुप्त व एम०सी० कुकरेती

सारॉंश

उत्तर मदूराई वन मण्डल, तमिलनाडु से मिले छोटे स्पष्ट नमूनों पर किये गये परीक्षणों के आधार पर हरे और आपाक शुष्क अकेसिया मिर्यसिआई के भौतिक और संधारी गुणों का विवरण यहां दिया गया है। प्राप्त परिणामों की तुलना टेक्टोना ग्राण्डिस (सागौन) से की गई है। शक्ति-आपेक्षिक गुरूत्व सूत्र के आधार विभिन्न विशिष्टताओं की अनुमानित अर्हाएं भी सूचित की गई हैं तथा उनकी तुलना हरी लकड़ियों में प्रेक्षित अर्हाओं से की गई है। निर्भय कर्न्यकारी दबाव और अन्तरिम उपयुक्तता निर्देशाकं भी सूचित किये गये हैं और उनकी तुलना सागौन की उन्हीं अर्हाओं के साथ की गई है। देखा यह गया है कि यह काष्ठ जाति सागौन से घटिया है। इस काष्ठ जाति की प्रेक्षित अर्हाएं शक्ति-आपेक्षिक गुरुत्व संबंधों के आधार पर प्रत्याशित अर्हाओं से भी निम्न पाई गई हैं।

References

I S.I. (1969). Method of testing small clear specimens of timber, IS : 1708–1969.

I.S.I. (1974). Method of sampling of model trees and logs for timber testing and their conversion, IS : 2455–1974.

Chudnoff, M. (1980). Tropical timbers of the world Forest Products Laboratory Madison WI 53705

Farmer. R.H. (1972). *Handbook of Hard woods*, 2nd Edition. Building Research Establishment, Princess Risborough Laboratory. Aylesbury, Buckinghamshire.

Rao, K.R & S.K Purkayastha (1972) Indian woods—their indentification, properties and uses III Manager of Publications, Delhi.

Sekhar, A.C. & A.S. Gulati (1972). Suitability indices of Indian timbers for industrial and engineering uses, *Ind. For. Rec.* (New series) 2 (1). Manager of Publications. Delhi.

Sekhar, A.C. & S.S. Rajput (1972). Safe working stresses of Indian timbers *Ind. For. Rec.* 2 (2). Manager of Publications, Delhi.

Sekhar, A.C. & B S. Rawat (1959). Studies on effect of specific gravity on strength considerations of Indian timbers. Journ. Inst. Engn. XXXIX (8) Part I.

USE OF KENAF AND ROSELLE AS PAPERMAKING FIBRES

Y.K. SHARMA, S.N. DHOUNDIYAL AND G.M. MATHUR

Cellulose and Paper Branch,
Forest Research Institute & Colleges, Dehra Dun

Introduction

Small Paper mills have eome up in large number all over the country during the last decade. These paper mills use agricultural residues, waste paper, purchased pulp, rags and hessian for production of writing and printing papers, wrapping papers and corrugating medium. Agriculture residues and waste papers are sources from which only short fibred pulp can be obtained and admixture of long fibre becomes necessary for desired runnability.

The whole plant of kenaf *(Hibiscus cannabinus)* and Roselle *(Hibiscus sabdariffa)* when pulped, yields a pulp containing a mixture of long fibres and short fibres. Long fibres are obtained from the bast fibre and short fibres from the woody portion. Average long fibre component in both the cases is in the order of about 30 per cent. Thus, these plants fulfil the need of blend of long and short fibres for papermaking. These two plants can, therefore, be considered as ideal raw materials for papermaking.

In this paper an attempt has been made to study pulping of kenaf *(Hibiscus cannabinus)* and Roselle *(Hibiscus sabdariffa)* by sulphate process, hot soda process and cold soda process.

Raw materials

Hibiscus cannabinus (Kenaf or Mesta or Bimili or Bimilipatam jute) is an erect herbaceous annual with straight, slender, glabrous or prickly stem of 2.5 to 4 metre height. In India, it has been under cultivation since long and found distributed through out the country upto an elevation of about 1000 metres in the lower Himalayas. The plant is cultivated mainly as a fibre crop in the drier tracts of Andhra Pradesh, parts of Karnataka, Maharashtra, Madhya Pradesh and Bihar. *H. cannabinus* is essentially a tropical crop, thriving best in humid climate with a temperature range of 60–90°F during the growing season. It requires a rainful of 50-60 cm destributed evenly over a period of 4–5 months, followed by a dry period.

The trade names Mesta and Kenaf are common to both *H. cannabinus* and *H. sabdariffa* fibres.. *H. cannabinus* is also named in trade as Bimili or Bimilipatam jute, Ambari hemp and Deccan Hemp.

Kenaf or Bimili jute thrives in well-drained, sandy loam soil, neutral in reaction and containing considerable quantity of humus, it does not grow under water-logged conditions. The plant is mainly grown as Kharif crop and generally grown mixed with other crops; sown

from May to July and harvested in October–November. For fibre purposes, the harvesting is done at the flowering stage before seed setting; if delayed, the fibre obtained is coarse with little luster. The yield of the fibre ranges from 90.9 kg–545.4 kg per acre depending whether the crop is grown mixed or pure.

Bimili or Kenaf fibre is widely used for rope and cordage, coarse canvas sacks and gunny bags, floor matting.

H. sabdariffa (Roselle), an annual erect shrub with red or green stem practically unbranched or with branches near the base. A native of tropical Africa or Asia, *H. sabdariffa* is now found under cultivation throughout the tropics and comparises of a large number of cultivated types which, on the basis of their growth habit or end use, are classified broadly under two varieties, *H. sabdariffa* var *sabdariffa* and *H. sabdariffa* var *altissima*. The former includes types which are generally branched and pitmented and cultivated for the edible calyees; the latter includes tall-growing, practically unbranched types bearing inedible calyees, mainly cultivated for the stem fibre (Roselle).

H. sabdariffa var *altissima* (Roselle) a tall, vigorous and practically unbranched plant often attaining a height of 3-5 m; calyees fibrous, spiny and inedible. This variety is indigenous to West Africa and is grown widely in the Phillippines, Indonesia and, more recently, in parts of South Africa and North and South America.

Roselle has attained prominence as a jute substitute. It is particularly successful in Bengal, it is also cultivated in Bihar, Assam. Tamil Nadu and Andhra Pradesh. It withstands drought and is not damaged by cattle.

The plant is well adopted to all types of soils, but thrives best in moderately fertile, well drained, permeable soil. It tolerates a certain degree of acidity or alkalinity in the soil, but is sensitive to forest. It requires a moist climate, high temperature throughout the growth period, and medium rainfall; vegetative growth is vigorous during the season of long days and the plant begins to flower and fruit as the days begin to shorten. In Tamil Nadu and Andhra, roselle is grown mostly on dry land in rotation with other crops; it is cultivated in wet lands only to a small extent.

The crop is harvested at the bud stage, when both out-turn and quality of fibre are good. Yields ranging from 1–6 tons per acre have been recorded under favourable conditions.

Roselle fibres are employed for sacking, cordage, rope, fishing nets and generally for all purposes for which jute is used. Bags made of Roselle fibre are extensively employed in Java for packing sugar. The stalks left over after fibre extraction are used as fuel.

The above two raw materials, 50 kg each, were received from Research Range Officer, Shivrajpur, Madhya Pradesh. Both the raw materials were cut in the pilot plant chaff cutter to 2–4 cm length. These chips were used in laboratory experiments.

Fibre dimensions

Fibre dimensions were determined of both the raw materials. Separate measurements were taken for best fibres and of fibres from woody portion. Average fibre length, diameter and wall thickness are recorded in Table 1.

Pulping

The chips of both Roselle and Kenaf were pulped by the following three processes :

Sulphate process
Hot soda process
Cold soda process

Pulping by soda process of Roselle has been published earlier. (Guha, *et al.*, 1978).

Sulphate pulping. Chips of Roselle and Kenaf were digested by sulphate process in a 3 litre electrically heated rotary digester using 25% sulphidity and a chip to liquor ratio of 1 : 6. The quantities of chemical were varied from 14 to 18 per cent. All the digestions were carried out at 162°C for a period of 3½ hours which included one hour to raise the temperature of the content to the maximum cooking temperature from room temperature. After the digestion the pulps were washed and unbleached yield was determined. The unbleached pulps were beaten in Lampen Mill to about 250 ml CSF freeness.

For pulp evaluation standard pulp sheets of about 60 gsm basis weight were made on the Standard British Sheet Making Machine. The sheets were pressed and dried in air using rings and plates. The sheets were conditioned to 65 per cent R.H. and 27°C temperature. The conditioned sheets were tested for strength properties. The digestion condition, pulp yields, and pulp evaluation results are recorded in Table 2.

Hot soda pulping. The chips were boiled in caustic soda solution in an open vessel at 95–97C° temperature for one hour. The chips were washed with fresh water and refined in two stages using a laboratory sprout Waldron disc refiner at a clearance of 0.25 mm and 0.025 mm After refining the pulps are again washed and unbleached pulp yields were determined.

Pulps prepared under different conditions were evaluated in a similar manner as that in case of sulphate pulps. Pulping conditions, pulp yields and pulp evaluation results are recorded in Table 3.

Cold soda pulping. Cold soda pulps were prepared from these two raw materials separately. The chips were soaked in different concentrations of caustic soda solution. A material to liquor ratio of 1 : 8 was maintained in all the cases. Soaking was done for a period of 4 hour at room temperature under atmospheric pressure. After the treatment excess liquor was drained off and the chips were washed once with fresh water. The washed chips were refined in laboratory Sprout Waldorn disc refiner. The chips were given three passes at 0.5 mm, 0.25 mm and 0.025 mm clearance at 5 per cent consistency. Pulp yields at different conditions of treatment were determined.

Table 1

Fibre–Dimensions

Place of origin	*Hibiscus sabdariffa* (Roselle)			*Hibiscus cannabinus* (Kenaf)		
	Average fibre length (mm)	Average fibre diameter (μ)	Average cellwall thickness (μ)	Average fibre length (mm)	Average fibre diameter (μ)	Average cellwall thickness (μ)
Bast fibre	3.05	21.91	5.6	2.5	20 98	4.5
Woody portions	0.799	32.1	2.9	0.739	28.83	4.13

Table 2

Pulping of Hibiscus sabdariffa (Roselle) and Hibiscus canabinus (Kenaf) by sulphate processes

Name of the species	Total chemicals as NaOH* (%)	Unbleached pulp yield* (%)	Breaking length (m)	Burst factor	Tear factor	Remarks
Hibiscus sabdariffa (Roselle)	14	55.2	8970	58.06	64.4	Hard cooked pulp was obtained
	16	52.2	11,880	64.2	71.5	Well cooked pulp
	18	49.1	12,040	63.1	80.7	,,
Hibiscus cannabinus (Kenaf)	14	50.7	6750	50.0	80.0	Hard cooked pulp was obtained
	16	49.0	6800	53.3	93.3	Well cooked pulp
	18	46.0	9440	63.0	104.6	,,

* percentage expressed on the basis of oven-dry chips.

Table 3

Hot soda cooking of Hibiscus sabdariffa (Roselle) and Hibiscus cannabinus (Kenaf)

Name of the species	Total chemical as NaOH* (%)	Unbleached pulp yield* (%)	Breaking length (m)	Burst factor	Tear factor
Hibiscus	6	78.6	4570	21.5	64.5
sabdariffa	8	77.7	5795	31.6	60.0
(Roselle)	10	75.1	6300	33.3	58.3
	12	73.5	6855	36.6	55.0
Hibiscus	6	82.1	4435	20.0	53.3
cannabinus	8	77.0	4940	20.4	60.0
(Kenaf)	10	74.4	5400	25.0	64.2
	12	70.6	5950	26.3	66.6

* Percentage expressed on the basis of oven-dry chips.

Pulp evaluation of these pulps were carried out in similar manner as recorded for sulphate pulps. The pulping conditions, pulp yields and pulp evaluation results are recorded in Table 4.

Table 4

Cold soda pulp from Hibiscus sabdariffa (Roselle) and Hibiscus cannabinus (Kenaf)

Name of the species	Caustic soda on oven-dry material* (%)	Unbleached pulp yield* (%)	Breaking length (m)	Burst factor	Tear factor
Hibiscus	4	83.2	2420	5.9	33.0
sabdariffa	6	82.6	2700	8.9	53.5
(Roselle)	8	81.9	4370	18.7	57.8
	10	79.2	5880	26.8	47.3
Hibiscus	4	85.0	2020	8.3	46.6
cannabinus	6	83.1	2420	11.6	58.0
(Kenaf)	8	80.0	2650	14.0	62.5
	10	78.5	3430	16.8	66.6

* Percentage expressed on the basis of oven-dry chips.

Conclusion

The results of sulphate pulping are recorded in Table 2. Under the conditions studied unbleached pulp yield of Roselle *(H. sabdariffa)* was higher than Kenaf *(H. cannabinus)*. The pulp evaluation of these pulps also show that Roselle pulps were better in strength properties than Kenaf pulps.

The experimental results of hot soda pulping are recorded in Table 3. Results show that both Roselle and Kenaf can be pulped by this process. Pulps in good yields and of good strength can be prepared by hot soda process from these raw materials.

In Table 4 results of cold soda pulping of Roselle and Kenaf have been reported. The results show that pulps of satisfactory yield and strength properties can be prepared from these two raw materials. Under the conditions studied Roselle gave better strength than Kenaf except tear.

On the basis of the above results it can be concluded that Roselle *(H. sabdariffa)* and Kenaf *(H. cannabinus)* are suitable raw materials for pulping by sulphate, hot soda and cold soda processes of pulping. They give good yields by these processes and the strength of properties unbleached pulps are good.

References

"*The wealth of India*", Raw Materials, V (H–K) pp. 77–84.

"*The wealth of India*", Raw Material V (H–K) pp. 92–96.

S.R.D. Guha, Y.K. Sharma and S.N. Dhoundiyal (1978). Pulping of *Hibiscus sabdariffa* Linn. (Roselle). *Ind, For.*, **104,** (12) : 830–837.

GRASSES OF PUNJAB

PART I

M. SHARMA

Department of Botany,
Punjabi University, Patiala (Punjab)

Introduction

Important Floras or botanical reports that deal with the erstwhile composite Punjab or any part of it include Edgeworth (1838, 1842), Aitchison (1868, 1869), Stewart (1869), Coventry (1901), Collett (1902), Bamber (1916), Parker (1918), Kashyap & Joshi (1936) and Sabnis (1940, 1941). Introduction of several new species and three divisions of the Punjab since 1947 have made the scope of these works rather limited for the present Punjab. Added to this is the inadequate treatment of grasses and sedges in these works which either have not been included at all or else not dealt with in detail. With the aim of writing the Flora of the reorgnised Punjab (India), this author has been making plant collections from this region for about eighteen uninterrupted years. Some preliminary contributions giving the accounts and/or enumerations of the vegetation of some districts (Sharma & Sharma 1966–1968, Sharma 1974 a, Sharma & Sharma 1974, 1975 1976) or of the entire province (Sharma 1975 a, 1977, 1978 a, 1979 a) have already been made to lay the foundation of this proposed Flora. Besides, 3 new plant records for India (Sharma 1975 b, 1976, 1980), one for North India (Sharma 1974 b) and 85 for Punjab State (Sharma 1973, 1978 b, 1979 b, c) have also been reported during this period from the area under study The most recent contribution covering the entire reorgnised State of Punjab is by Nair (1978). In criticism it is sufficient to point out here that as many as 48 grasses not recorded by him have been listed here. An additional point which warrants the urgency of the present paper is a remark by Jain *et al.* (1972, p 45; published 1975), in connection with the regional accounts of grasses in India during the period 1961–1970, which reads: "the states of Punjab, Haryana, Maharashtra, Andhra Pradesh, Kerala, Orissa, Assam and Andamans had only one paper or no work at all". It is indeed a sad commentary on the studies of economically so important a group as grasses that they have remained neglected for so long from this region. The present paper is an endeavour to fill that lacuna and is based on the plant collections made by the author himself eversince July, 1963.

Notes on Topography, Geology, Soils and Climate of the area have already been given in author's publications mentioned above and hence are not repeated. Present Punjab essentially is a plain country with arid to semi-arid climate, very high (up to 48.3°C) to pretty low (recorded up to 1.7°C) temperatures and moderate (up to 110 cm per year) to scanty (48 cm per year) rainfall Somewhat moister Siwaliks with the annual rainfall of 85-125 cm delimit the Punjab along its north-eastern borders.

General accounts of the grasses

Monsoon grasses. The occurrence and distribution of the grasses in the area is mainly affected by edaphic and climatic factors prevailing during the different seasons of the year. For the majority of the grasses the monsoon period (July-September) is the most congenial for growth, development and survival. The advent of the drier season results in their death or they manage to tide over the inhospitable seasons through their underground perennating parts.

A typical vegetation of grasses becomes more and more pronounced just after the first monsoon showers Common weeds of kharif crops are *Acrachne racemosa* Ohwi, *Chloris montana* Roxb., *Cynodon dactylon* Pers, *Dactyloctenium aegyptium* P Beauv., *Dinebra retroflexa* Panz., *Eragrostis ciliaris* R. Br., *E Japonica* Trin., *E. pilosa* P. Beauv., *E poaeoides* P. Beauv., *Leptochloa panicea* Ohwi add *Sorghum halepense* Pers.

Due to the special marshy habitat provided by the paddy-fields, some typical grasses inhabit these. Important ones are *Echinochlao colonum* Link, *E. crusgalli* P. Beauv., *E. stagnina* P. Beauv, *Eriochloa nubica* Thell., *Hemarthria compressa* R. Br., *Ischaemun rugosum* Salisb. and *Paspalum paspalodes* Scribn. *Digitaria stricta* Roem. & Schult is sometimes found along the borders of rice-fields. In contrast, *Cenchrus biflorus* Roxb., *Eragrostis ciliaris* R. Br, *E. tremula* Steud. and *Perotis hordeiformis* Hook. & Arn. thrive exceedingly well in sandy groundnut-fields.

On the raised embankments of the cultivated fields *Cynodon dactylon* Pers., *Imperata cylindrica* P. Beauv., *Saccharum bengalense* Retz., *S. ravennae* Murray, *S. spontaneum* Linn., *Setaria glauca* P. Beauv. and *Vetiveria zizanioides* Nash are common.

While *Dactyloctenium aegyptium* P. Beauv, *Digitaria ciliaris* Koel., *Eragrostis pilosa* P. Beauv., *Setaria glauca* P. Beauv. and *S. intermedia* Roem. & Schult. are common in garden beds, others like *Cynodon dactylon* Pers, *Eragrostis tenella* Roem. & Schult., *Eriochloa nubica* Thell., *Oplismenus burmannii* P. Beauv., *Paspalidium flavidurm* A. Camus and *Setaria intermedia* Roem. & Schult are common as an undergrowth in gardens and orchards.

The abundance of grasses during rainy months is noticed in waste places. Grasses commonly occurring in such localities are *Acrachne racemosa* Ohwi, *Aristida adscensionis* Linn, *A. funiculata* Trin. & Rupr., *Bothriochloa pertusa* A Camus, *Brachiaria distachya* Stapf, *B. ramosa* Stapf, *B. reptans* Gard. & C E. Hubb., *Cenchrus ciliaris* Linn., *C. pennisetiformis* Steud, *C. setigeruu* Vahl, *Chloris virgata* Sw., *Cynodon dactylon* Pers., *Dactyloctenium aegyptium* P. Beauv, *Desmostachya bipinnata* Stapf, *Dichanthinm annulatum* Stapf, *Digitaris ciliaris* Koel, *D setigera* Roth, *Eleusine indica* Gaertn, *Eragrostis diarrhena* steud., *E. japonica* Trin., *E. pilosa* P. Beauv, *E. poaeoides* P. Beauv., *E. tenella* Roem. & Schult., *Panicum psilopodium* Trin., *P. trypheron* Schult., *Paspalidium flavidum* A. Camus, *Saccharum bengalense* Retz, *S. ravennae* Murray, *S. spontaneum* Linn., *Setaria glauca* P. Beauv, *S. intermedia* Roem. & Schult., *S. verticillata* P. Beauv., *Sorghum halepense* Pers., *Sporobolus*

coromandelianus Kunth, *S. diander* P. Beauv., *S. marginatus* A. Rich., *Tragus roxburghii* Panigrahi and *Urochloa panicoides* P. Beauv.

Bothriochloa pertusa A. Camus, *Brachiaria distachya* Stapf, *B ramosa* Stapf, *Cynodon dactylon* Pers., *Dichanthium annulatum* Stapf, *Eragrostis pilosa* P. Beauv., *E. tenella* Roem. & Schult., *Imperata cylindrica* P. Beauv., *Paspalidium flavidum* A. Camus, *Setaria glauca* P. Beauv , *Sporobolus diander* P. Beauv. and *Urochloa panicoides* P. Beauv. deserve a special mention as the inhabitants of lawns and pasture grounds.

In forests, tall and perennial grasses like *Phragmites karka* Steud., *Saccharum bengalense* Retz , *S spontaneum* Linn. and *Vetiveria zizanioides* Nash are very conspicuous in water stagnated localities and *Panicum antidotale* is occasionally common to abundant among bushes or thickets. *Brachiaria ramosa* Stapf, *B. reptans* Gard. & C. E. Hubb., *Cenchrus ciliaris* Linn., *C. pennisetiformis* Steud., *Cynodon dactylon* Pers , *Dactyloctenium ageyptium* P. Beauv., *Dichanthium annulatum* Stapf, *Digitaria ciliaris* Koel., *D. setigeria* Roth, *Eriochloa nubica* Thell., *Oplismenus burmannii* P. Beauv., *O. compositus* P. Beauv., *Panicum psilopodium* Trin., *Paspalidium flavidum* A. Camus, *Setaria glauca* P. Beauv., *S. verticillata* P. Beauv., *Sporobolus diander* P. Beauv. and *Urochloa panicoides* P. Beauv. are the constituents of the ground grass-flora In places where water accumulates *Echinochloa colonum* Link and *E. crusgalli* are quite conspicuous.

Apluda mutica Linn., *Cenchrus ciliaris* Linn., *C. pennisetiformis* Steud., *Chloris dolichostachya* Lagasca, *Digitaria setigera* Roth, *Panicum antidotale* Retz., *P. maximum* Jacq. and *Setaria verticillata* P. Beauv. are common in the bushes and hedges.

Among the aquatic and marshy grasses mention may be made of *Eohinochloa colonum* Link, *E. crusgalli* P. Beauv., *E. stagnina* P. Beauv., *Eriochloa nubica* Thell., *Eragrostis atrovirens* Steud , *Hemarthria compressa* R. Br., *Iseilema prostratum* Anders., *Leersia hexandra* Sw., *Oryza rufipogon* Griff , *Panicum paludosum* Roxb , *Paspalum paspalodes* Scribn and *Phragmites karka* Steud. which grow in water or along the sides of water courses and some of them, not infrequently, colonize the entire area. *Cynodon dactylon* Pers., *Digitaria stricta* Roem. & Schult , *Imperata cylindrica* P. Beauv. and *Setaria glauca* P. Beauv. are common on the embankments of irrigation courses. *Saccharum bengalense* Retz. and *S. spontaneum* Linn. are abundant on the sandy 'Cho'-beds. *Vetiveria zizanioides* Nash thrives exceedingly well and is usually gregarious in puddles.

Common components of the grass-flora of the sandy tract and frequently not uncommon on sand dunes are *Aristida adscensionis* Linn., *A. funiculata* Trin. & Rupr., *Cenchrus biflorus* Roxb., *C. ciliaris* Linn., *C. pennisetiformis* Steud., *C. setigerus* Vahl, *Cymbopogon jwarancusa* Schult., *C. olivieri* Bor, *Cynodon dactylon* Pers., *Dactyloctenium sindicum* Boiss., *Digitaria ciliaris* Koel., *Eragrostis ciliaris* R. Br., *E. tremula* Steud., *Heteropogon contortus* Roem. & Schult., *Lasiurus hirsutus* Boiss., *Perotis hordeiformis* Hook. & Arn , *Saccharum bengalense* Retz. and *Tragus roxburhiii* Panigrahi.

Desmostachya bipinnata Stapf, *Saccharum spontaneum* Linn., *Sporobolus coromandelianus* Kunth and *S. marginatus* A. Rich. are the only grasses in the area which can survive on saline and alkaline soils locally called as 'Kallar'.

Grasses commonly and usually plentifully distributed in the Siwaliks are *Alloteropsis cimicina* Stapf, *Aristida funiculata* Trin. & Rupr., *Arthraxon lancifolius* Hochst., *Arundinella nepalensis* Trin., *Bothriochloa pertusa* A. Camus, *Chloris dolichostachya* Lagasca, *Chrysopogon serrulatus* Trin., *Cymbopogon jwarancusa* Schult., *C. martinii* Wats., *C. olivieri* Bor, *C. parkeri* Stapf, *Cynodon dactylon* Pers., *Dendrocalamus strictus* Nees, *Eragrostiella nardoides* Bor, *Eulaliopsis binata* Stapf, *Hackelochloa granularis* O. Ktze., *Heteropogon contortus* Roem. & Schult., *Melanocenchris abyssinica* Hochst. and *Pogonatherum paniceum* Hack.

Winter grasses. Grasses of the winter season (November-March) are mainly the weeds of cultivation or survive in moist localities only. Common weeds of cultivation are *Avena fatua* Linn., *Lolium temulentum* Linn., *Phalaris minor* Retz. var. *nepalensis* Bor. *Polypogon monspeliensis* Desf. is found along the borders of cultivated fields and in garden beds. Sometimes forming their pure communities or otherwise very common along water courses are *Alopecurus nepalensis* Steud., *Lophochloa phleoides* Reichb., *L. pumila* Bor and *Polypogon monspeliensis* Desf. *Lophochloa phleoides* Reichb., *Poa annua* Linn. *and Polypogon monspeliensis* Desf. are the most prominent grasses in lawns.

Summer grasses. The extremely hot weather and scarcity of water during May-June makes it impossible for the majority of the grasses to survive. Still some of the perennial xerophytic grasses like *Cymbopogon jwarancusa* Schult., *Dactyloctenium sindicum* Boiss., *Desmostachya bipinnata* Stapf, *Dichanthium annulatum* Stapf, *Heteropogon contortus* Roem. & Schult., *Lasiurus hirsutus* Boiss., *Panicum antidotale* Retz., *Sorghum halepense* Pers and *Sporobolus marginatus* A. Rich. flower during this period. Others like *Cynodon dactylon* Pers, *Digitaria ciliaris* Koel., *Eragrostis atrovirens* Steud., *E. poaeoides* P. Beauv., *Leersia hexandra* Sw., *Polypogon monspeliensis* Desf and *Setaria glauca* P. Beauv. flower in garden beds, moist lawns or along irrigation courses where enough moisture is provided for their survival. The characteristic grass of Siwaliks *Eulaliopsis binata* C.E. Hubb. also flowers during this period. Most of these grasses continue flowering during rainy months.

Food crops. Hordeum vulgare Linn, *Oryza sativa* Linn.. *Pennisetum typhoides* tapf & C.E. Hubb., *Sorghum bicolor* Moench, *Triticum aestivum* Linn. and *Zea mays* Linn are cultivated as food crops throughout the area. *Eleusine coracana* Gaertn. and *Setaria italica* P. Beauv. are also cultivated to some extent for the same purpose in the hilly tract of the state. *Saccharum barberi* Jeswiet and *S. officinarum* Linn. are cultivated for their thick, juicy, sugar-yielding stems.

Fodder grasses. Avena sterilis Linn., *Pennisetum typhoides* Stapf & C.E. Hubb, *Sorghum bicolor* Moench and *Zea mays* Linn. are often grown as fodder crops. The straw ('turi') of *Hordeum vulgare* Linn. and *Triticum aestivum* Linn. are also very commonly used as fodder. The wild species listed below are either gathered as fodder or grazed by cattle :

Alloteropsis cimicina Stapf, *Apluda mutica* Linn., *Avena fatua* Linn., *Bothriochloa pertusa* A. Camus, *Brachiaria ramosa* Stapf, *B. reptans* Gard. & C.E. Hubb., *Cenchrus biflorus* Roxb., *C. ciliaris* Linn., *C. pennisetiformis* Steud., *C. setigerus* Vahl, *Chrysopogon serrulatus* Trin., *Cynodon dactylon* Pers., *Dactyloctenium aegyptium* P. Beauv., *Dichanthium annulatum* Stapf, *Digitaria ciliaris* Koel., *D. setigera* Roth, *Dinebra retroflexa* Panz., *Echinochloa colonum* Link, *E. crusgalli* P. Beauv., *E. stagnina* P. Beauv., *Eragrostis atrovirens* Steud., *E. pilosa* P. Beauv., *E. poaeoides* P. Beauv., *E. tenella* Roem. & Schult., *E. tremula* Steud., *Eriochloa nubica* Thell., *Hemarthria compressa* R Br, *Heteropogon contortus* Roem & Schult. (young plants only), *Iseilema prostratum* Anderss., *Lasiurus hirsutus* Boiss., *Leersia hexandra* Sw., *Panicum maximum* Jacq., *Perotis hordeiformis* Hook. & Arn., *Phalaris minor* Retz. var. *nepalensis* Bor, *Poa annua* Linn., *Polypogon monspeliensis* Desf., *Setaria glauca* P. Beauv., *Sorghum halepense* Pers., *Sporobolus diand.r* P. Beauv., *Themeda quadrivalvis* O. Ktze. and *Urochloa panicoides* P. Beauv.

Ornamentals and hedge-plants

Arundo donax Linn. var. *versicolor* Stokes and *Thysanolaena maxima* O. Ktze. are sometimes seen in the gardens as ornamental grasses. *Arundo donax* Linn., *Bambusa nutans* Munro, *B. vulgaris* Wendl. and *Dendrocalamus strictus* Nees are plant d in botanic gardens or as hedge-plants especially in the sub-mountainous zone and the low-hills.

Miscellaneous local uses

A valuable cordage fibre, locally called 'munj' is obtained from the upper leaf-sheaths of the flowering culms of *Saccharum bengalense* Retz. Its sticks are used for making rough stools, cheap toys, chairs and screens, and for staking sweet peas (*Lathyrus odoratus* Linn.). The plant is used for thatching and against frost and 'loo' for protecting the young plants in the gardens. The dyed inflorescense is used for decorations. *Saccharum spontaneum* Linn. is also used for thatching and its culms are also put to the same uses of preceding species and for making country pens. The culms of *Vetiveria zizanioides* Nash are used for making brooms. *Eulaliopsis binata* C.E. Hubb. is collected and sold for papermaking.

Statistical synopsis

The number of genera and species in various tribes (arranged alphabetically) of the two subfamilies of the Gramineae will be evident at a glance from the Table 1. Besides 128 species as is clear from Table 1, 5 additional varieties are also listed. Out of these 19 species are cultivated for various purposes and the rest are wild or naturalized.

New records

Complete absense of the family Gramineae or its inadequate teatment in the previous works dealing with the plants of Punjab and thrice recognized Punjab since the publication of these studies make it rather difficult to pin-point the recently introduced grasses within the present Punjab. Nevertheless, a critical perusal and comparative study of the list with the

Table 1

Number of genera and species in various tribes of Gramineae

Subfamilies	Tribes	No. of Genera	No. of Species
Panicoideae	Andropogoneae	20	30
	Paniceae	13	38
	Maydeae	2	2
Pooideae	Agrostideae	2	2
	Aristideae	1	2
	Arundineae	2	2
	Arundinelleae	1	1
	Aveneae	2	4
	Bambuseae	2	3
	Chlorideae	4	7
	Eragrosteae	9	21
	Festuceae	2	2
	Oryzeae	2	3
	Perotideae	1	1
	Phalarideae	1	1
	Sporoboleae	1	5
	Thysanolaeneae	1	1
	Triticeae	2	2
	Zoysieae	1	1
Grand total		69	128

works mentioned in the very beginning of this paper and Hook. f. (1896) show that following 19 grasses are new records for the Punjab plains :

Chloris montana Roxb., *C. virgata* Sw., *Chrysopogon serrulatus* Trin., *Cymbopogon olivieri* Bor, *C. parkeri* Stapf, *Digitaria longiflora* Pers , *D. stricta* Reom. & Schult., *Dinebra retroflexa* Panz , *Eriochloa nubica* Thell., *Lasiurus hirsutus* Boiss., *Leersia hexandra* Sw., *Lolium*

temulentum Linn. var *arvense* Lilj., *Lophochloa pumila* Bor, *Oplismenus burmannii* P. Beauv., *Oryza rufipogon* Griff., *Panicum maximum* Jacq , *Paspalum scrobiculatum* Linn., *Perotis hordeiformis* Hook. & Arn. and *Phalaris minor* Retz var. *nepalensis* Bor.

Systematic enumeration of species

For convenience, the disposition of tribes within the subfamilies, of genera within the tribes and of species within a particular genus is alphabetical. Nomenclature has been adopted almost exclusively from Bor (1973) and hence for economizing space, the synonyms have been excluded as these have been dealt with comprehensively in that book. The general distribution and flowering and fruiting periods for each species are recorded. Local names, if available, have also been given. The voucher herbarium specimens running into 542 field numbers are housed in the herbaria of Punjab University Chandigarh (collected, during July 1963 to April 1966 and indicated by a single asterisk). Punjab Agricultural University, Ludhiana (collected from May 1966 to September 1968 and indicated by double asterisks) and Punjabi University, Patiala (collected eversince October 1968 and unmarked). The list is not purported to be complete, its comprehensiveness notwithstanding.

Subfamily PANICOIDEAE

Tribe Andropogoneae

Apluda mutica Linn.

Rare to common among hedges and bushes. Fl. and Fr. July-Nov.

Sharma 2307*, 2291

Var. aristata (Linn.) Hack. ex Backer

Distribution, flowering and fruiting periods as of the type.

Sharma 2941, 3000

Arthraxon lancifolius (Trin.) Hochst.

Common in Siwaliks in shady places. Fl and Fr. Aug.-Oct.

Sharma 2291*

Bothriochloa pertusa (Linn.) A. Camus

Common in lawns and pastures and frequently associated with *Dichanthium annulatum* Stapf with which it resembles much. Pitted lower glume helps to segregate it from the latter. Plentiful in Siwaliks also Fl. and Fr. Aug.-Oct.

Sharma 2298*, 1323, 1381, 1418, 1515, 2942

Chrysopogon serrulatus Trin.

Very common in exposed situations in Siwaliks, occasionally seen in the nearby plains also. Fl. and Fr. Aug -Oct.

Sharma 2302*, 3765, 4305

Cymbopogon citratus (DC.) Stapf
Cultivated in botanic gardens.

C. jwarancusa (Jones) Schult.
Common, particularly in Siwaliks and the drier areas of the state. Fl. and Fr. May-Sept.
Local names : Ganni, Khawi
Sharma 2299*, 177**, 3962, 4540

C. martinii (Roxb) Wats
Common in Siwaliks. Fl and Fr. Aug -Oct.
Sharma 3797

C. olivieri (Boiss.) Bor
Common in Siwaliks and the drier parts of plains. Fl. and Fr. July-Sept.
Sharma 3204

C. parkeri Stapf
Common in Siwaliks, very rare in plains. Fl. and Fr. July-Sept.
Sharma 2513

Dichanthium annulatum (Forsk.) Stapf
Common to abundant in waste places, lawns, pastures and on the embankments of cultivated fields. Found in Siwaliks also. Fl. and Fr. Mar.-Nov.
Local names : Palvan, Zirga
Sharma 2300*, 696**, 263, 1449, 3461, 3885

Eulaliopsis binata (Retz.) C E. Hubb.
Common in Siwaliks. Fl. and Fr. Mar.-Aug.
Sharma 2702*

Hackelochloa granularis (Linn.) O. Ktze.
Common in Siwaliks, escapes in the nearby plains. Fl. and Fr. Aug.-Oct.
Sharma 2496*, 1433, 2975, 4302

Hemarthria compressa (Linn f.) R. Br.
Common to abundant and frequently gregarious along water courses, in stagnant water and rice-fields. Fl. and Fr. July-Nov.
Sharma 2779*, 200**, 914, 2895, 2932, 3987

Heteropogon contortus (Linn.) P Beauv. ex Roem. & Schult.
Common in Siwaliks and the drier parts of the plains. Fl. and Fr. July–Nov., Mar.–Apr. Local names : Shurval, Lamboo
Sharma 2494*, 175**, 1322, 1607, 2263, 2845, 4285

Imperata cylindrica (Linn.) P. Beauv.

Common weed in lawns and other moist, grassy places like embankments of irrigation courses, canals and cultivated fields. An obnoxious weed. It is almost impossible to eradicate it because of the deep-seated rhizome which enable it to withstand the mowing of lawns where the sharp apices of the emerging plants are quite annoying to the visitors. Fl. and Fr. Mar.-Nov.

Local names : Dabb, Kusa, Sir

Sharma 2311*, 203**, 293, 1797, 3237, 3932, 6285

Ischaemum rugosum Salisb.

Common in rice-fields. Fl. and Fr. Aug.-Oct.

Sharma 2289*, 1450, 2209, 2952, 4640

Iseilema prostratum (Linn.) Anderss.

Common near stagnant water. Fl. and Fr. July-Oct.

Sharma 2781*, 1420, 1494, 2224, 4332

Lasiurus hirsutus (Forsk.) Boiss.

Common on sand-dunes. Fl. and Fr. Apr.-June.

Sharma 4543

Pogonatherum paniceum (Lamk.) Hack.

Very rare. Fl. and Fr. Mar.-June.

Sharma 2713*

Rottboellia exaltata Linn. f.

Rare. Fl. and Fr. Aug.-Sept.

Sharma 2765*

Saccharum barberi Jeswiet

Cultivated for its sugar-yielding culms.

S. bengalense Retz.

Common to abundant and often gregarious throughout the plain country in waste places, forests, plantations, raised embankments around fields and alluvial deposits of streams. Fl. and Fr. Oct.-Dec.

Local names : Kana, Sarkada, Sarkanda

Sharma 2306*, 330**, 146, 5638, 6523, 6528

S. officinarum Linn.

Cultivated for its thick, juicy stem. Fl. Mar. (occasional).

Local names : Ganna, Kamad

Sharma 794

S. ravennae (Linn.) Murray

Common in the plain country. Fl. and Fr. Oct.–Dec.

Local names : Cana, Sarkada, Sarkanda

Sharma 1640, 6517, 6524, 6527

S. spontaneum Linn.

Abundant and gregarious throughout the plain country in wet and water-logged localities, alluvial soils of rivers, in dry to very dry places and in and along the borders of cultivated fields. Fl and Fr. Aug.–Sept.

Local names : Kahi, Kans

Sharma 2295*, 174**, 390, 989, 1329, 1389, 2160, 2853

Sorghum bicolor (Linn.) Moench

Commonly cultivated as a dual-purpose crop for fodder and grains. Fl. and Fr. Aug.–Oct. or earlier depending upon sowing season.

Local names : Chari, Joar, Jowar

Sharma 2705*, 329**, 1514

S. halepense (Linn.) Pers.

Very common and trouble some weed of cultivation and waste places. Fl. and Fr., Mar.–Nov. Lingers on in Dec. also.

Local name : Baru

Sharma 2305*, 143**, 373, 1500, 4040, 4394, 5130

Themeda quadrivalvis (Linn) O. Ktze.

Rare to fairly common, sometimes common and gregarious in the Punjabi University lawns, Patiala. Fl. and Fr. Oct.–Dec.

Sharma 2287, 2517, 3232, 4043, 4370

Vetiveria zizanioides (Linn.) Nash

Common to abundant and gregarious, inhabiting the puddles along roadsides. Sometimes found in the waste places and embankments of fields. Fl. and Fr. June–Oct., Mar. near water.

Sharma 2689*, 276**, 133, 1404, 1507, 4009

(To be continued)

RESEARCH NOTE

Preliminary field study on Snakes as Agents of Management of Rodent Populations

During the Snake Specialist Group meeting in November, 1982 in Madras, a field trip was undertaken to a nearby village, Puduppakkam in Chingleput District along with two Irula tribals (snake and rodent catchers) to crop fields infested with rodents.

The habitat of the study farm contained sapota, mango, guava, paddy and cocount crops heavily damaged by rodents The wild plants cover was mainly represented by *Calotropis procera, Strachytor abita indica, Cardiospermum indicum, Azardichta indica, Acalypha indica, Achyrhynthus aspera, Leucis biflorus, Rhandia* sp, *Capparis* sp. etc, providing protective habitat to snakes as well as rodents. The mean annual rainfall is 1370 mm and mean annual temperatures are 31 6°C max. and 25.6°C min. respectively. The relative humidity was 81 per cent. The soil is sandy loam, red in colour.

Digging out of live burrows of rodents with marks or 'runways' of rodents as well as snakes showed absence of rodents, eaten or chased away by snakes and presence of rat snakes *(Ptyas mucosus)* (Plate 1). Recent rodent nests made from prevalent grasses were collected in these abandoned burrows Several species of arthropods including whip scorpions *(Thelophonus* sp.), millepedes *(Bolydes* sp.), reduvid bugs and mantids were collected inside the rodent burrows. In all cases, termites and combed termataria were found in burrows. Several lizards like *(Sitana ponticeriana)*, Chameleon *(C zeylanicus)* and skinks *(Mabuya carinata)* were collected in the habitat.

The farm was heavily infested with rodents and the number of rodent burrows per acre ranged from 80 to 125. Damage to the coconut crop was observed to be about 25.0 per cent. The Indian gerbil, *Tatera indica* was found to be the predominant rodent followed by the field mouse, *Mus booduga* (Table 1). Numerous three striped palm squirrels *(Funambulus* sp.) were observed in the area. Among snakes, the rat snake *(Ptyas mucosus)* and saw-scaled viper *(Echis carinatus)* were two predominant predators of rodents. At the opening of one rodent burrow, several bird feathers were collected indicating additional food preferences of prevalent rat snakes. In one case, the burrow had been blocked by *Tatera indica*, perhaps to restrict entry of the snake, whose ventral makings were seen (Plate 2).

Discussion

These few observations are preliminary to a proposed quantitative analysis of the rodent-eating habits of snakes and their value in prevention of food losses due to rodent damage. It is casually observed that size and ecological factors are prime determinants of preferential predation by snakes on different rodent species. For example in this study the small saw-scaled viper's main (or only) rodent prey could be the field mouse while the rat snake was seen to be closely associated with the larger gerbil and soft-furred rat.

These lines of investigation have not been carried out in India though abundant ancedotal information and data from captive feeding of snakes at Madras Snake Park indicate that about 12 species af snakes common throughout much of India feed commonly or even exclusively on rodents. Table 2 presents a list of these snakes and rodents they are known to or surmised to feed on. Feeding rates for some species in captivity will be presented in a following paper (Whitaker and Shekar in prep.).

The authors gratefullv acknowledge the skilled assistance of Irula Snake catchers Cooperative members Chockalingam and Kuppam.

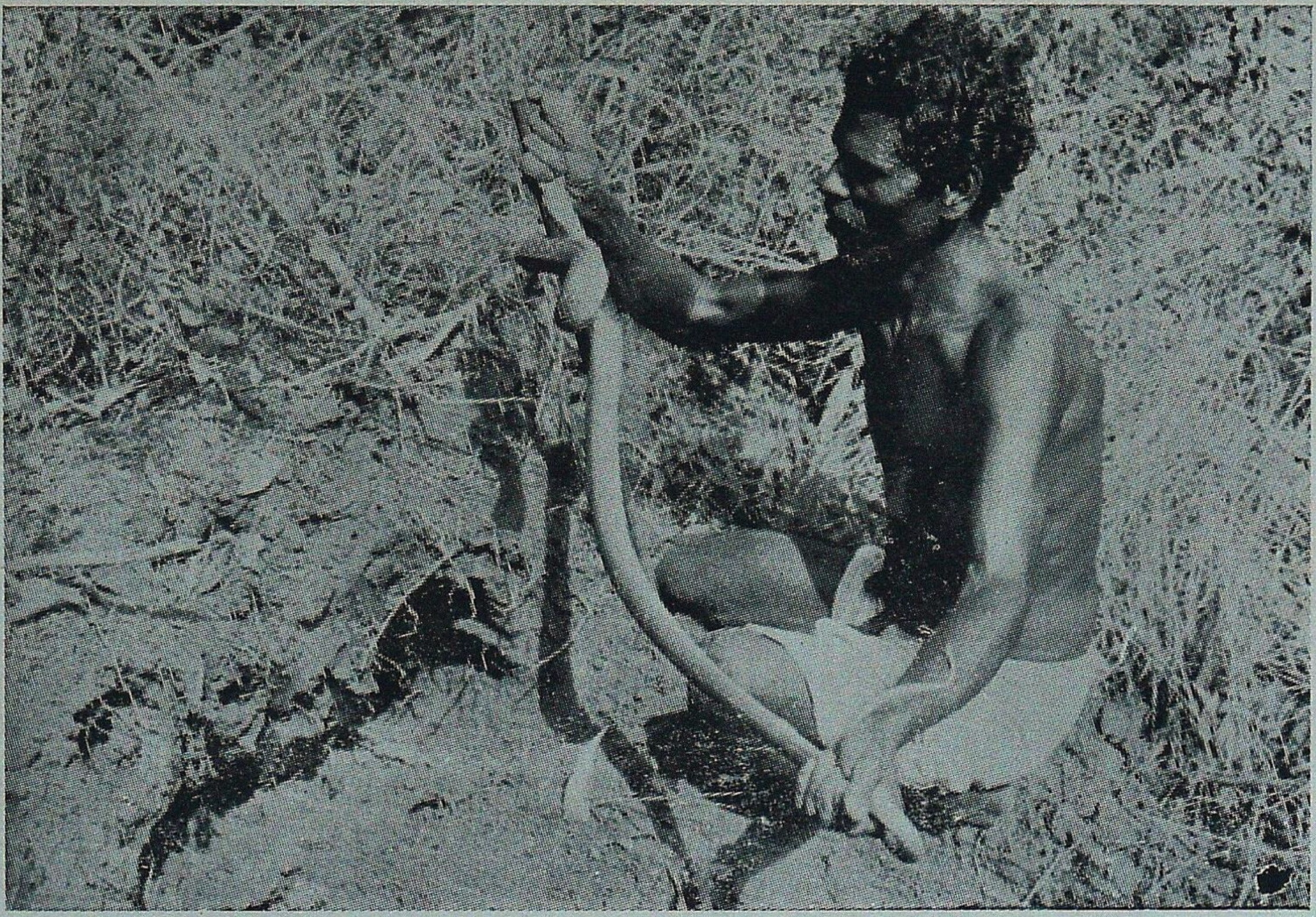
Table 1

Relationship between rodent and snake resident patterns in a farm near Madras

Rodent species (% occurrence)*		Snake species (% occurrence)*	
Indian gerbal *Tatera indica*	(46%)	Saw-scaled viper *Echis carinatus*	(28.5%)
Softfurred field rat *Rattus meltada*	(12%)	Striped keel-back *Amphiesma stolata*	(14.3%)
Field mouse *Mus booduga*	(30%)	Rat snake *Ptyas mucosus*	(28.5%)
Rock rat *Rattus cutchicus*	(10%)		
Spiny mouse *Mus platythrix*	(2%)	Vine snake *Ahaetulla nasuta*	(14.3%)
Squirrel *Funambulus* sp.	(pr.)	Cobra *Naja naja naja*	(pr.)
Black rat *Rattus rattus*	(pr.)	Russells viper *Vipera russellii*	(14.3%)
*On basis of burrow counting		*On basis of live collection, scats and sloughed skins in and around rat infested area.	

Photograph showing dug out rodent burrow system occupied by rat snake. The rat's nesting chamber with nesting material is visible near Chockalingam's right hand.

Plate 1



Adult rat snake (*Ptyas mucosus*) removed from rat burrow

Plate 2

Opening of rodent burrow (*Tatera indica*) with marks of runways of both rodent and snake. Freshly dug soil by the rodent is visible.

Table 2

List of common rodent-eating snakes in India

Snake		Likely rodent prey preference
Indian python	(*Python molurus*)	All larger species such as *Tatera, Bandicota* etc.
Common sand boa	(*Eryx conicus*)	Small to medium burrowers such as
Red sand boa	(*Eryx johnii*)	*Mus, Rattus meltada*
Trinket snake	(*Elaphe helena*)	Arboreal species such as tree rat and *Funambulus*
Rat snake	(*Ptyas mucosus*)	All species including *Bandicota*
Banded racer	(*Arggrogena fasciolatus*)	Small taxa such as *Mus*
Common krait	(*Bungarus caeruleus*)	*Mus* and *Rattus meltada*, young of larger taxa
Banded krait	(*Bungarus fasciatus*)	Same as common krait
Cobra	(*Naja naja naja*)	*Talera, Bandicota bengalensis, Rattus meltoda, Mus*
Russells viper	(*Vipera russellii*)	*Tatera indica*
Saw-scaled viper	(*Echis carinatus*)	*Mus* sp.
Pit vipers	(*Trimeresurus* sp.)	Arboreal species

Madras Snake Park Trust
P.O. Raj Bhavan
Madras-600 022
and
Central Plantation Crops Research Institute,
Kasaragod.

Romulus Whitaker
and
Ranjan Advani

--- ---

LETTER TO THE EDITOR

To

The Honorary Editor,
Indian Forester,
P.O. New Forest,
Dehra Dun

Sub.—**A Note on Two Abnormalities in *Dendrocalamus strictus* Nees.**

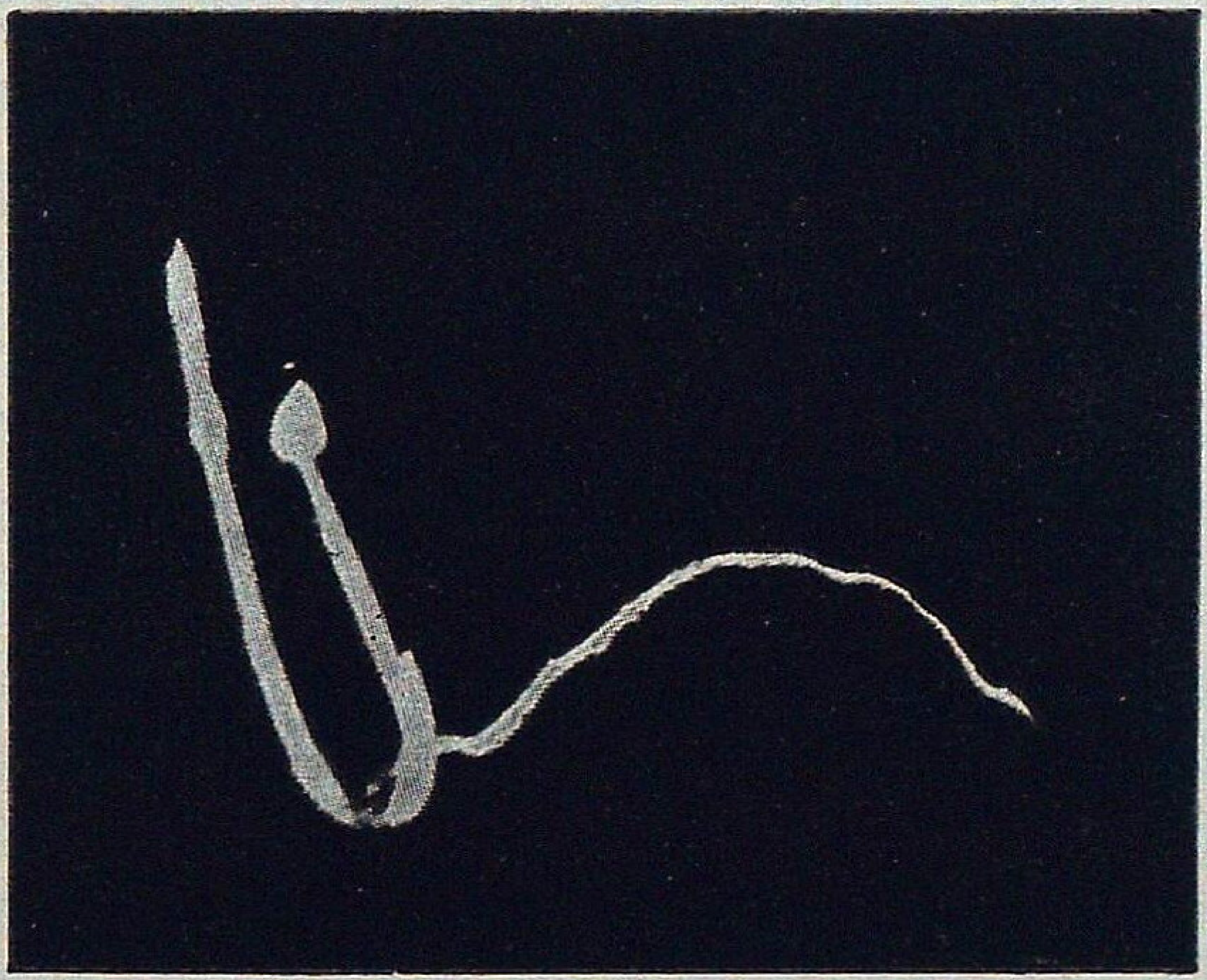
Sir,

During the study of vitality, viability and vigour of some forest tree seeds, one out of 800 seeds of *D. strictus* produced twin seedling. Seeds were collected in June, 1981 and stored in air tight polythene bags at room temperature (15–45°C) as well as in refrigerator at 5°C. Germination studies were performed with certain intervals. In Decmber, 1982 a twin seedling was produced by a seed from second lot (5°C).

Twin seedlings. Two plumules emerged from a single seed during germination. Both the plumules were with 1 mm gap between them and in the form of pointed conical buds with sheathing scale-like leaves. Mean while a common fibrous root developed from the base in between the two buds. Both the buds continued to grow simultaneously and developed into two stems, each bearing single leaf at each node arising alternately. The bases of the leaves were sheathing the stem. In twenty day period one branch became slightly longer than the other. Both the branches were green but their development was much slower than that of the normal seedlings. After 25 days this seedling was transformed into a tray filled with garden soil with five normal seedlings. The twin seedling with three normal seedlings died in ten days after transplanting.

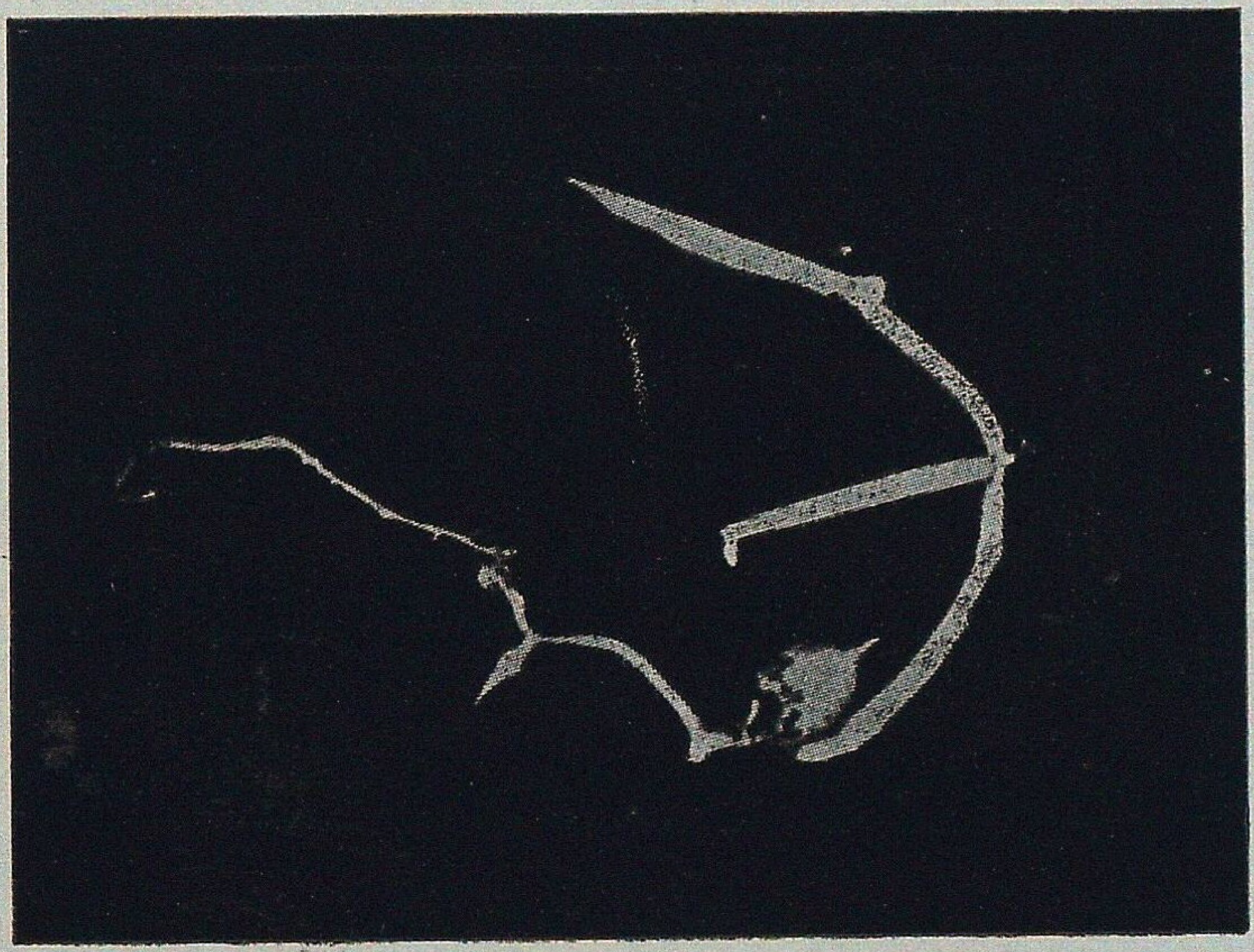
Dichotomy. After 10 days of germination it was observed that the plumule of one seedling divided into two branches at the second node. These two branches were similar at first but as growth proceeded, on branch became bigger than the other. After 20 days both the branches were almost equal in length but the leaf of one branch became large. At the

Plate 1



Twin seedlings of *Dendrocalamus strictus.*
(Note the emergence of root between the two seedlings)

Plate 2



Abnormal seedling of *D. strictus* showing shoot dichotomy.

juncture of these branches towards the opposite side of small branch, a tissue developed which looked as if there was a stunted root primordium. Both the branches were having one internode each and leaf was sheathing the stem. The smaller branch died after thirty days while the larger branch remained alive upto 45 days.

Yours faithfully,

Sd./- G.S. Babeley and A.K. Kandya
Department of Botany,
University of Saugar,
Sagar—470 003 (M.P.)

GAZETTE NOTIFICATIONS

ANDHRA PRADESH GAZETTE

The following transfers and postings of Asstt. Conservators of Forests are ordered on administration grounds with immediate effect :

1. Shri Masood Ali Khan, is posted as Asstt. Conservator of Forests, Statistical Cell, O/o the Chief Conservator of Forests, A.P., Hyderabad.

2. Shri T.V. Subba Rao is posted as Personnel Assistant to Conservator of Forests, Warangal Circle.

3. Shri M.V. Rama Rao is posted as Sub-Divisional Forest Officer, Nizamabad Headquarters, Banswada.

Shri T.V. Rangarajan, I.F.S., Conservator of Forests, Guntur Circle is kept in full additional charge of the post of Conservator of Forests, Social Forestry Circle, Vijayawada with immediate effect, relieving Shri C. Sarvotham Rao, I.F.S., Conservator of Forests, Social Forestry Circle, Hyderabad from the additional charge.

Shri C. Sarvotham Rao, I.F.S., is kept in full additional charge of the post of Conservator of Forests, Hyderabad Circle with immediate effect vice Shri G. Sudhakar Reddy, I.F.S., Conservator of Forests, Hyderabad.

On return from leave Shri K. Somasunder Rao Asstt. Conservator of Forests is posted as Sub-Divisional Forest Officer, Tirupathi relieving Shri U. Venugopal, I.F.S.. Divisional Forest Officer, Chittoor East of the additional charge.

Shri R.D. Reddy, I.F.S., Divisional Forest Officer, Social Forestry, Medak, headquarters at Sangareddy is transferred and posted as Project Director, District Rural Development Agency, Cuddapah vice Shri K. Chennaiah, Project Director, transferred.

On relief Shri K. Chennaiah, Joint Registrar, Cooperative Societies on deputation with District Rural Development Agency, Cuddapah as Project Director is repatriated to his parent department and directed to approach Registrar of Cooperative Societies for further posting orders.

U. P. GAZETTE

Shri Chandra Gupta, Conservator of Forests, Timber Supply Circle is transferred and posted as Conservator of Forests, Tehri Dam Circle.

FRI Publications

FOREST RESEARCH INSTITUTE AND COLLEGES, DEHRA DUN

Indian Forest Bulletins

No. 275—*Silvics*. Environmental effects of forest in India, by R.C. Ghosh, O.N. Kaul and B.K. Subba Rao. (Symbol No. PFRI. 188) Price Rs. 3.10 or £ 3.36 or $ 1.12.

Indian Forest Records

Vol. 3, No. 1-Wood Anatomy. Studies on the variation in Wood quality of *Eucalyptus tereticornis* Sm. trees grown in different plantations, Part-I—Wood specific gravity, by S K. Purkayastha, S.P. Agarwal, R D. Tondan and Laxmi Chauhan. (Symbol No. PFRI. 190). Price Rs. 5.[illegible]0. or £ 0.64 or $ 1.98.

Other Publications

Timber Engineering Manual, Part III—Theory and practice of Timber lemella frames (Design, fabrication and erection techniques), by N.J. Masani. (Symbol No. PFRI. 176) Price Rs 22.00 or £ 2.56 or $ 7.92.

Indian Woods : Their identification, properties and uses, Vol. IV–Myrtaceae to symplocaceae, by S.K. Purkayastha (Symbol No. PFRI. 177) Price Rs. 145.00 or £ 16.91 or $ 52 20.

Field indentification of fifty important timbers of India, by K. Ramesh Rao & K.B.S. Juneja (Reprinted 1983) (Symbol No. PFRI. 197) Price Rs. 10.00 or £ 1.17 or $ 3.60.

Abridged glossary of technical terms (For use in Forest Colleges). (Reprinted 1983). (Symbol No. PFRI. 193). Price Rs. 9.00 or £ 1 05 or $ 3.24.

Available from :—**The Controller of Publications, Department of Publications, Civil Lines, Delhi–110054**

FOREST DEVELOPMENT CORPORATION OF MAHARASHTRA LIMITED, NAGPUR.

(A Govt. of Maharashtra Undertaking)

We produce in bulk

Quality teak for plywood, veneering and saw milling.

Valuable non-teak logs and poles for various uses.

Bamboos.

Firewood.

Industrial grade charcoal,

Khair wood & Ain bark.

For particulars, contact :—

The Regional Manager,
Research & Marketing,
Forest Development Corporation
of Maharashtra Ltd., Nagpur—440010.

"WOOD IS GOOD"

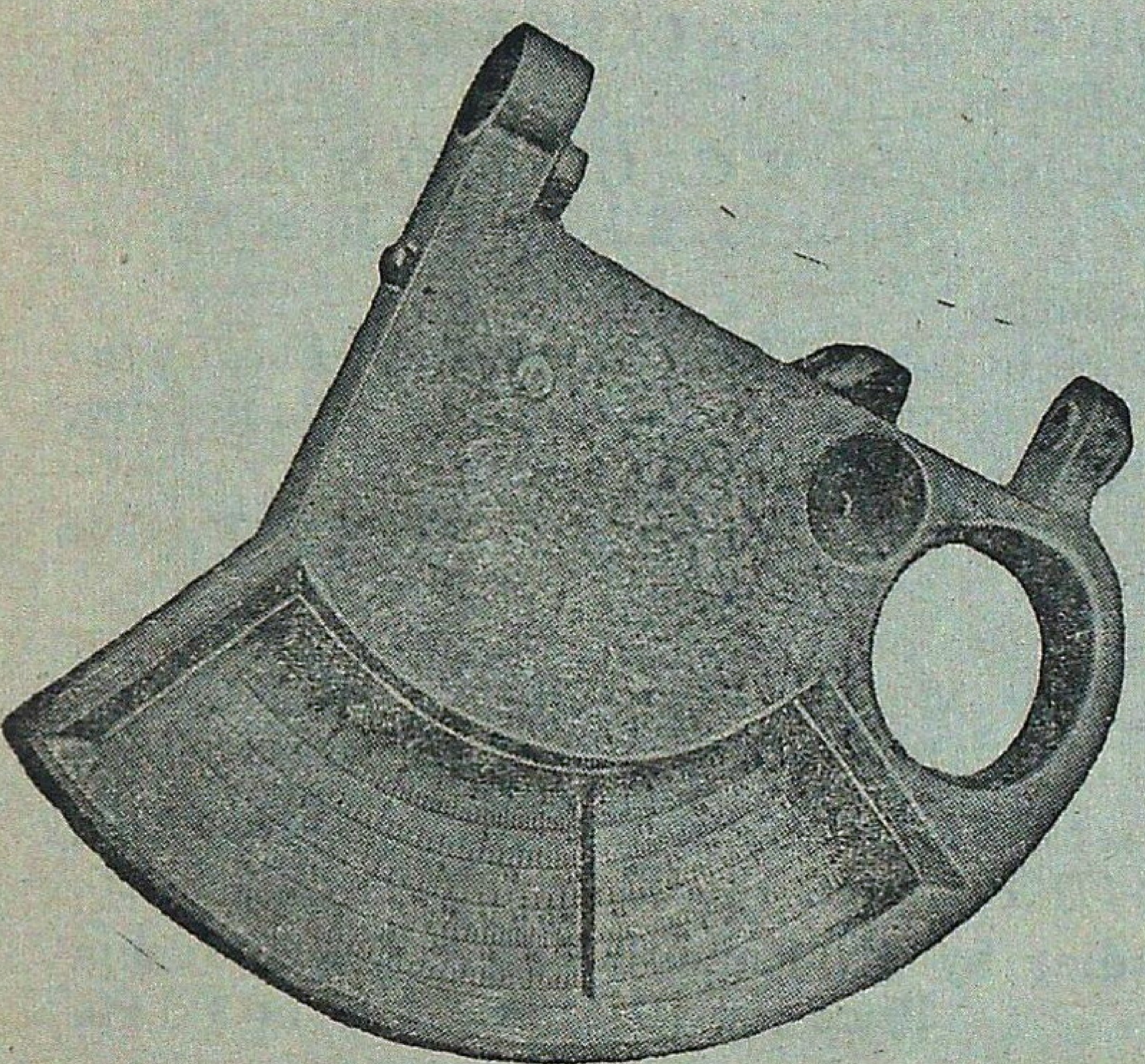
So is Asian Wood

With best compliments from :

Asian Woods & Polymers (P) Ltd.,

Long Island, Middle Andaman–744203

Primier manufacturing house of quality forestry instruments offers



RAVI MULTIMETER

(Patent A Nos. 000191, 000192 & 000222)

A must for every Forest Officer

Ravi Multimeter gives heights of individual trees in plain or in sloping grounds, Basal Area for four factors 0.5, 1.0,2.0 and 3.0 in metric units, Average Crop Height and Base Line, A very useful instrument for Working Plan, Pre-Investment Survey & Silvicultural Divisions.

Appreciated and being used by Forest Departments all over India.

RAVI ALTIMETER

(Patent A No. 000191)

For measurement of heights of individual trees in plain or sloping grounds.

Aluminium Double Legged Ladders of various specifications.

* * * *

Tree Callipers (Aluminium, wooden & metal bound) of various sizes.

* * * *

LIGHT WEIGHT INGLE LEGGED LADDER

Available in 12 sections each of 2.5 m in length (one base section, ten mid sections and one end section) Any height upto 30 m can be conveniently reached by adjusting numbers of mid sections. Simple to assemble and light to carry. Useful in measurement of standing sample of trees and in plucking of seeds, Leather safety belt for use of climber available separately.

Increment Borers, Fixed Iron Callipers, Bark Gauges, Tree Scribe (Bark Scrapper), Abney's Level, Topographic Abney's Level, Metallic and Steel Tapes, Bow Saws, Wedge Prisms and other Scientific Drawing and Surveying Instruments.

For further particulars please contact :—

Phone : 26636

RAVI VAGYANIK YANTRA NIRMATA

BHAGWAN DASS BUILDINGS, JUGMANDER STREET, DEHRA DUN, (U.P.) 248001

6. 8, 10. 12/82—2, 4/83

WUDGARD
The Wood Protector
made with
Castrol know how
FOR
• HOMES
• FACTORIES
• INDUSTRIES
Castrol
INDUSTRIAL
CASTROL LIMITED Bombay, Calcutta, Madras, New Delhi

NORVICSUN

The Moments of Life Time Experience await you—

IN SASAN-GIR

you have a date with the

King & Queen

of Animal World

The most Majestic Royal Animal species—

The Rare Asiatic Lione

For more details contact:

Deputy Conservator of Forests,
Wild Life Division,
P.O. Sasan-gir-362 135
Distt. Junagadh, Gujrat.

The Similipahar Forest Development Corporation Ltd.

(A GOVERNMEMT OF ORISSA UNDERTAKING)

BARIPADA

S.F.D.C.
ORISSA

Our Corporate goal is

★ To preserve and protect the Similipahar Forests;

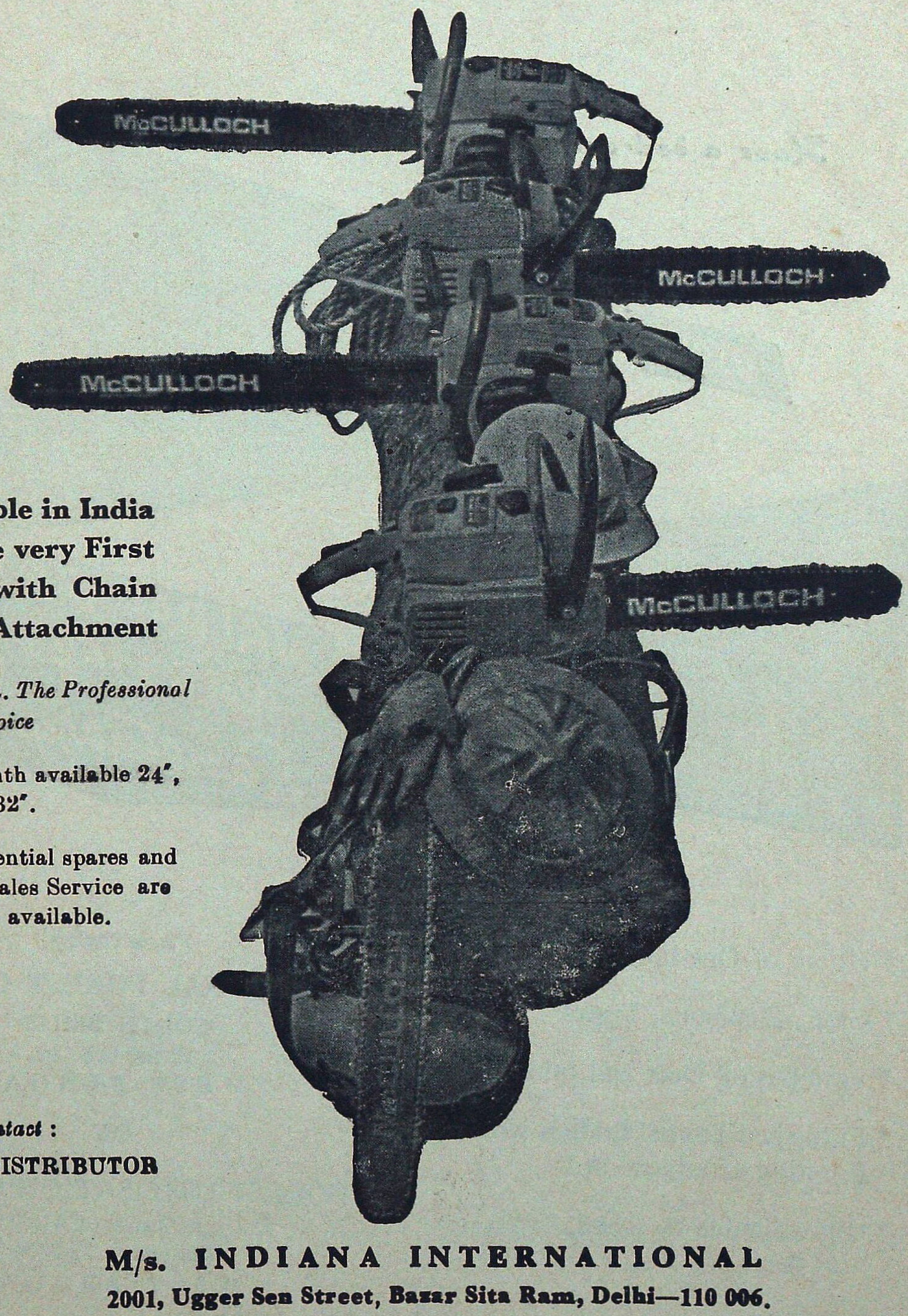
★ To improve and enrich the growing stock, and to nurse back to health the degraded patches in the project area;

★ To improve infrastructure like roads, godowns, rest houses and staff quarters; and

★ To intensity collection of M.F.P.

We have grown from a turnover of Rs. 43 lakhs during 1979-80 to Rs. 580 lakhs during 1981-82.

1/83—12/83



Available in India for the very First Time with Chain Brake Attachment

McCulloch. The Professional Dealer Choice

1. Bar lenth available 24″, 28″ & 32″.
2. All essential spares and after Sales Service are readily available.

Please Contact :

"SOLE DISTRIBUTOR in India".

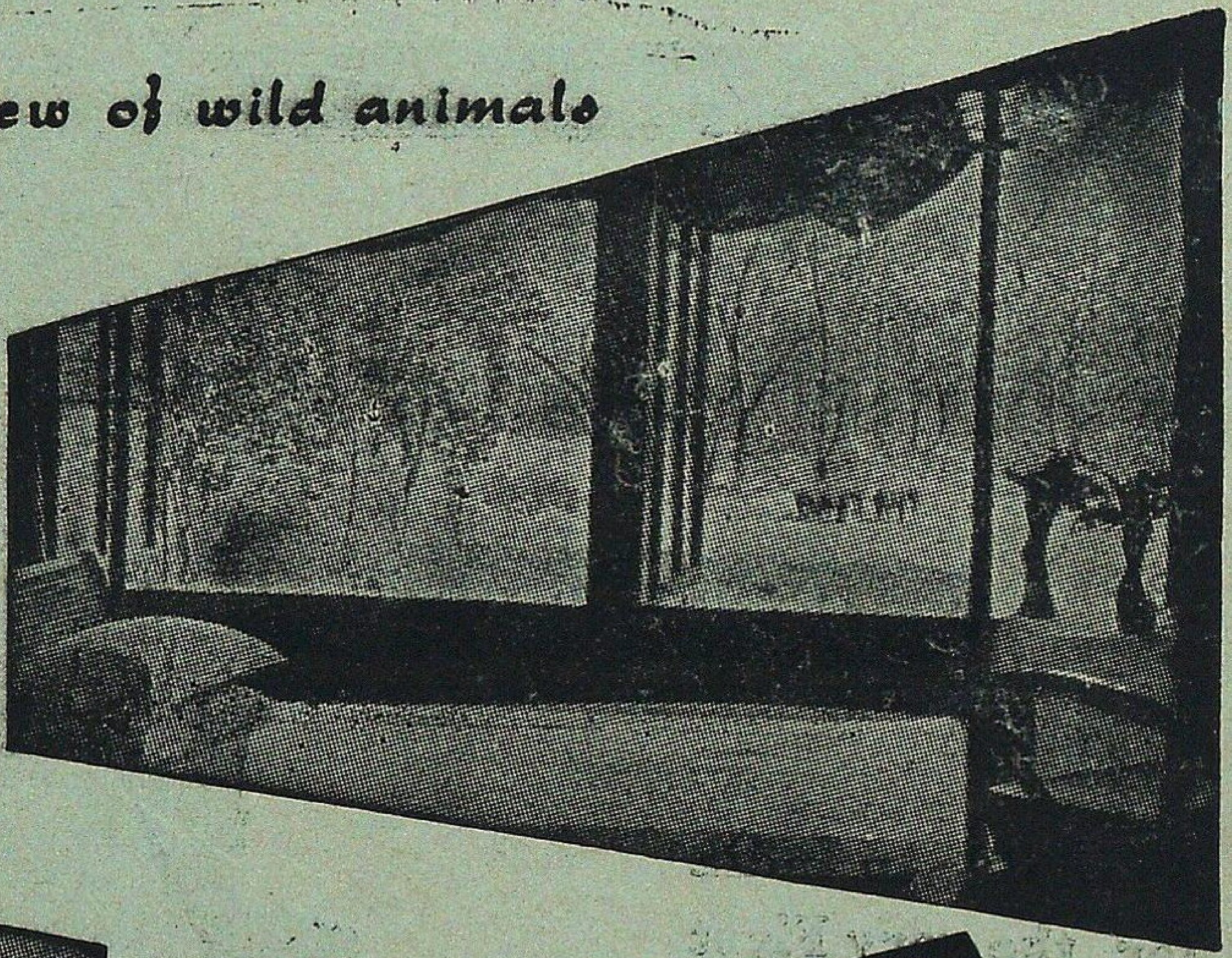
M/s. INDIANA INTERNATIONAL

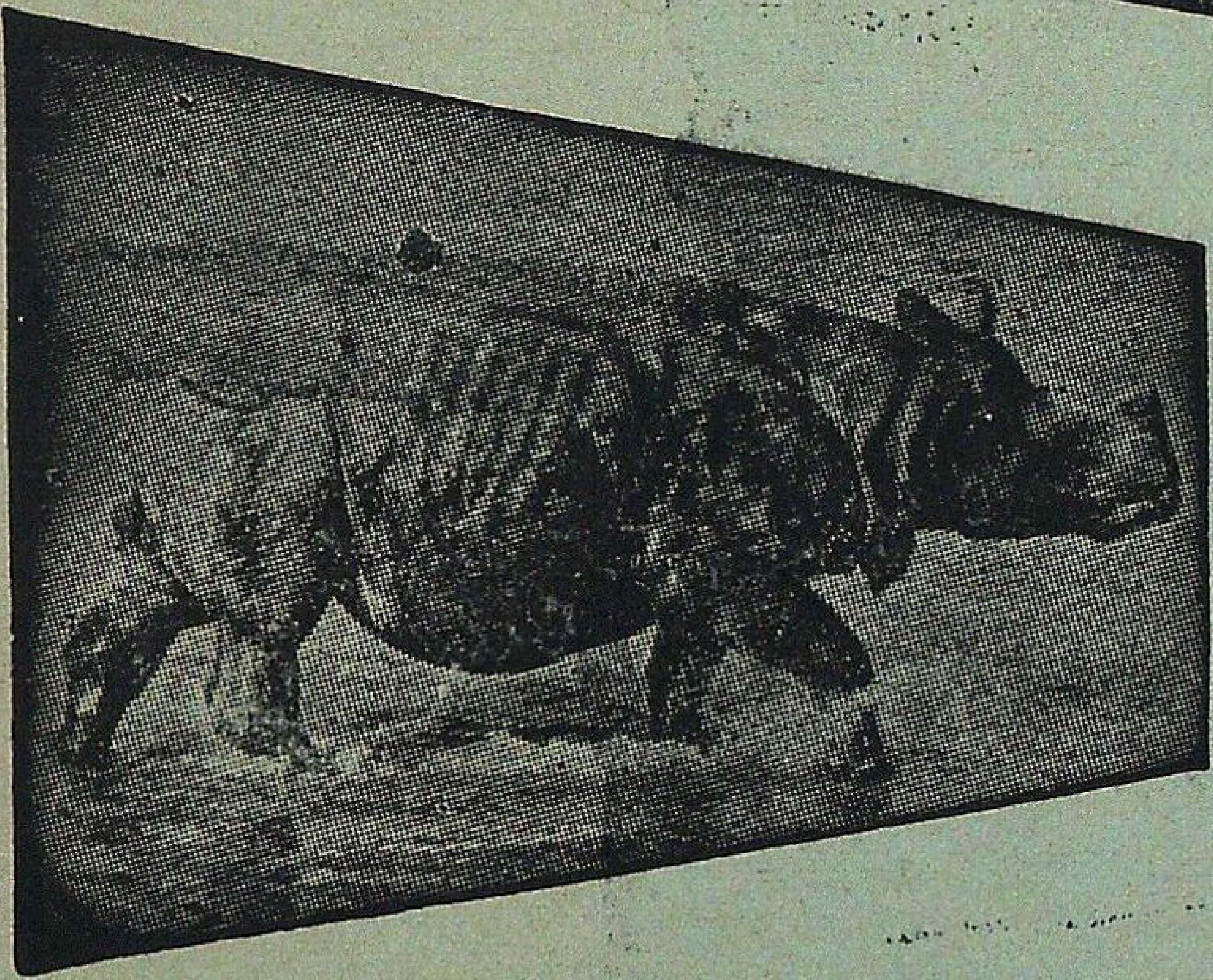
2001, Ugger Sen Street, Bazar Sita Ram, Delhi—110 006.

Phone : 264868, 261250 **Grams : "POWERCHAIN"**

Have a bedroom view of wild animals

VISIT





JALDAPARA WILD LIFE Sanctuary

* Home of One-horned Rhinoceros.
* Gaur, Elephants, Tigers.
* Varieties of Deer and other Animals
* Furnished Tourist Lodges with full Catering arrangement.
* Approachable by Road, Train and Air.
* Jeep available.

Please contact :

DIVISIONAL FOREST OFFICER
COOCH BEHAR
[Phone C.B. 247]
WEST BENGAL

OR

FOREST UTILISATION OFFICER
8, Lyons Range, CALCUTTA
[Phone : 22-2774]
WEST BENGAL

3/82—2/83

VISIT : **Palamau National Park**

*Famous for the abundance and variety of wild life—Ti ger, Panther, Elephant, Gaur, Samber, Spotted deer, Barking deer and numerous species of beautiful birds,

*Picturesqui Scenery.

*A place of historical importance—the old and the new Palamau Fort of Chero Kings.

*Ideal holiday resort.

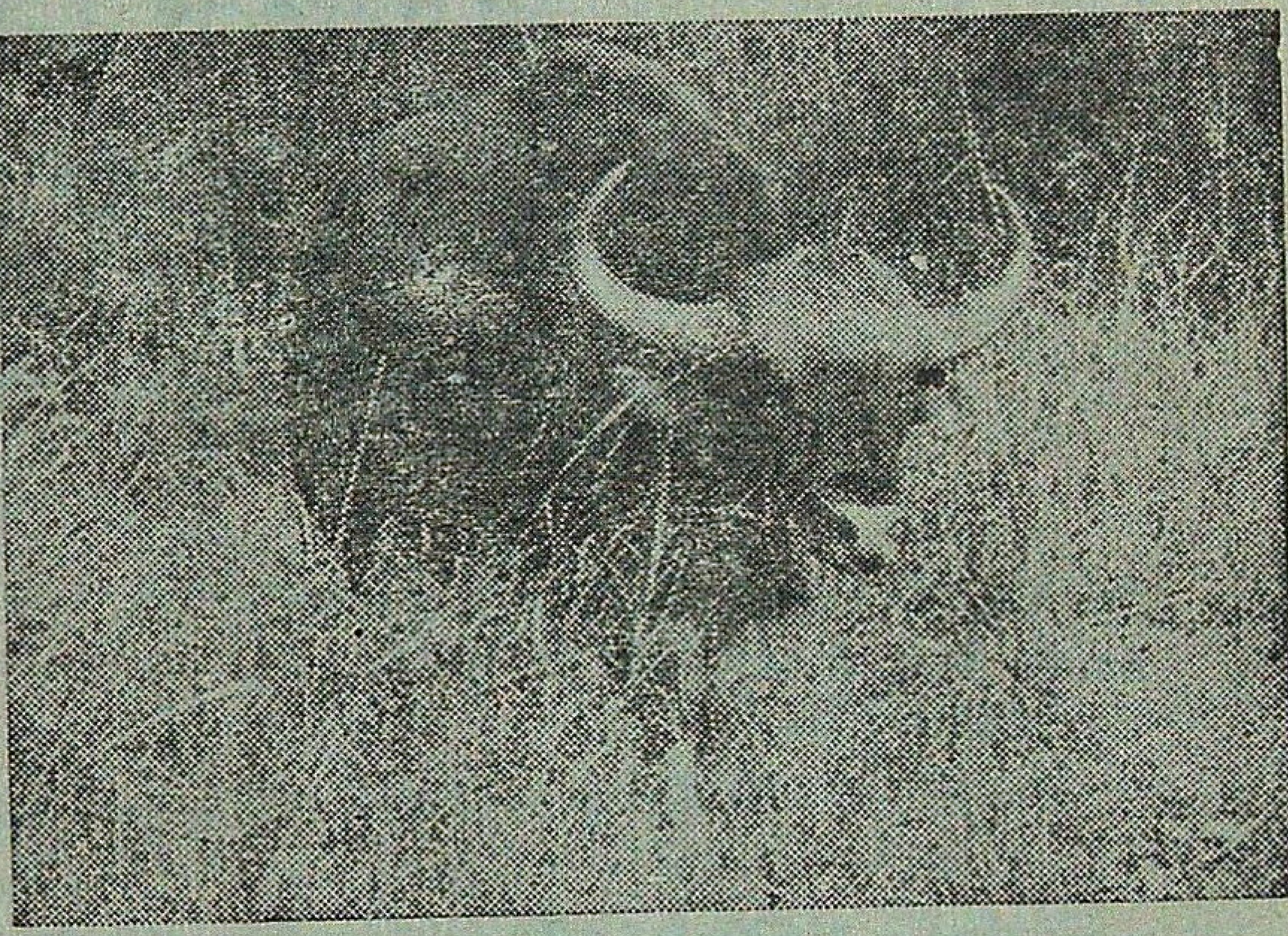
*Well furnished tourist Lodges and Forest Rest Houses with catering arrangement.

*Beautiful Watch Towers, tree-top and Hide-outs-all connected by roads.

*Remains open throughout the year.

*Snaps and movie permitted free of charge.

*Approachable by road and rail—26 kms from Daltonganj and 12 kms from Chhipadohar Rly. Station. Well connected by roads with comfortable Bus service.
Nearest Airport—Ranchi—175 kms.



For further particulars write to :

THE FIELD DIRECTOR, PROJECT TIGER,
Palamau Tiger Reserve,
P.O. Daltonganj, Bihar (India)

3/82—2/83

Six years of Achievement :
Six years of Progress :
MADHYA PRADESH RAJYA VAN VIKAS NIGAM LIMITED
Rededicates itself for rehabilitation of Green-Glory.

★ 38284 ha of Teak and Bamboo Plantation Raised.
★ 1585 ha of Tropical Pines Raised.

Modest Contribution to Forest-based industrialization :-

★ Bastar Wood Products, Jagdalpur — a joint venture.

★ Narmada Wood Products, Itarsi — our sole enterprize.

★ Wood Working Centres to impart skill to — rural artisans.

Annual Employment generated .90 lakh man-days.
Annual wages distributed Rs. 350 lakhs.

With best Compliments from :

MANAGING DIRECTOR
M.P. RAJYA VAN VIKAS NIGAM LIMITED
PANCHANAN, MALVIYA NAGAR,
BHOPAL (MADHYA PRADESH)

WHATEVER YOUR NEED

There is a Species of

ANDAMANS TIMBERS

TO SUIT YOUR REQUIREMENTS

CONTACT :

1. The Chief Conservator of Forests,
Andamans & Nicobar Islands,
Port Blair.

2. The Deputy Conservator of Forests
(Depot Division)
Andamans Govt. Timber Depot,
3-A, 2nd Floor, Auckland Place,
Calcutta—17.

3. The Assistant Conservator of Forests,
(Depot Division)
Andamans Govt. Timber Depot,
Marshalling Yard, Port Trust, MADRAS.

3/82—2/83

AVPL

OUR BRAND :
FORCOPLY
FORCODECOR
FORCOBOARD
FORCODOOR

OUR PRODUCT :
PLYWOOD
BLOCKBOARD
FLUSHDOOR

PHONE : OFFICE—26-5226 27-0061 FACTORY—611-331 GRAM : VANUDYOG

ALOK UDYOG VANASPATI & PLYWOOD LTD.

6-A, RAJA SUBODH MULLICK SQ., CAL-13
7th Floor

AUTHORISED CONTROLLER

WEST BENGAL FOREST DEVELOPMENT CORPN. LTD.

(GOVT. OF WEST BENGAL UNDERTAKING)

WHAT WILL YOU DO ?
GO TO THE ZOO

NANDANKANAN

BIOLOGICAL PARK

INVITES YOU

* A Bioaesthetic complex......situated inside a sanctuary.. in the relaxing environs of peace, tranquility and soothing natural beauties.

* Its enchanting Wild Life, attraction of the shore-walk under the shady groves along the lake, thrill of Elephant ride, etc. etc.

* Comfortable stay at the most reasonable rates in well furnished lake view tourist lodges......an ideal holiday resort (for reservation, write to Wild Life Conservation Officer, Orissa, 145-Saheed Nagar, Bhubaneswar -751 007)

* Please see the spot of rare events :
  (i) Of a Tigress surrendering her independence,
  (ii) The five White Tiger Cubs born to normal-coloured parents,
  (iii) Successful breeding of Gharials in captivity for first time in the World.

  And, also—

  (iv) The Wild Tusker "Agasti", captured by Tranquillisation (the first Elephant to be captured by this method), and now under training.

* Approachable by rail from Barang, Cuttack and Bhubaneswar stations and by road from Bhubaneswar.

* You can also avail the conducted sight seeing tourist bus service of the Orissa Tourism Development Corporation from Bhubaneswar and from puri for seeing Nandankanan and other places of interest.

Forest Department, ORISSA.

We have pleasure to introduce ourselves as :

* Producers of Round Timber for Veneering and Saw Mill.
* Manufacturers of Tea chests and Commercial Plywood.
* Supplier of Sawn Timber and Furniture.
* Cultivators of Coffee, Cardomom, Rubber, Cocoa, Tea and other cash crops.
* Manufacturers of Match and Polythene Bags.

Arunachal Pradesh Forest Corporation Limited

(A Govt. of Arunachal Pradesh Undertaking)

DEOMALI

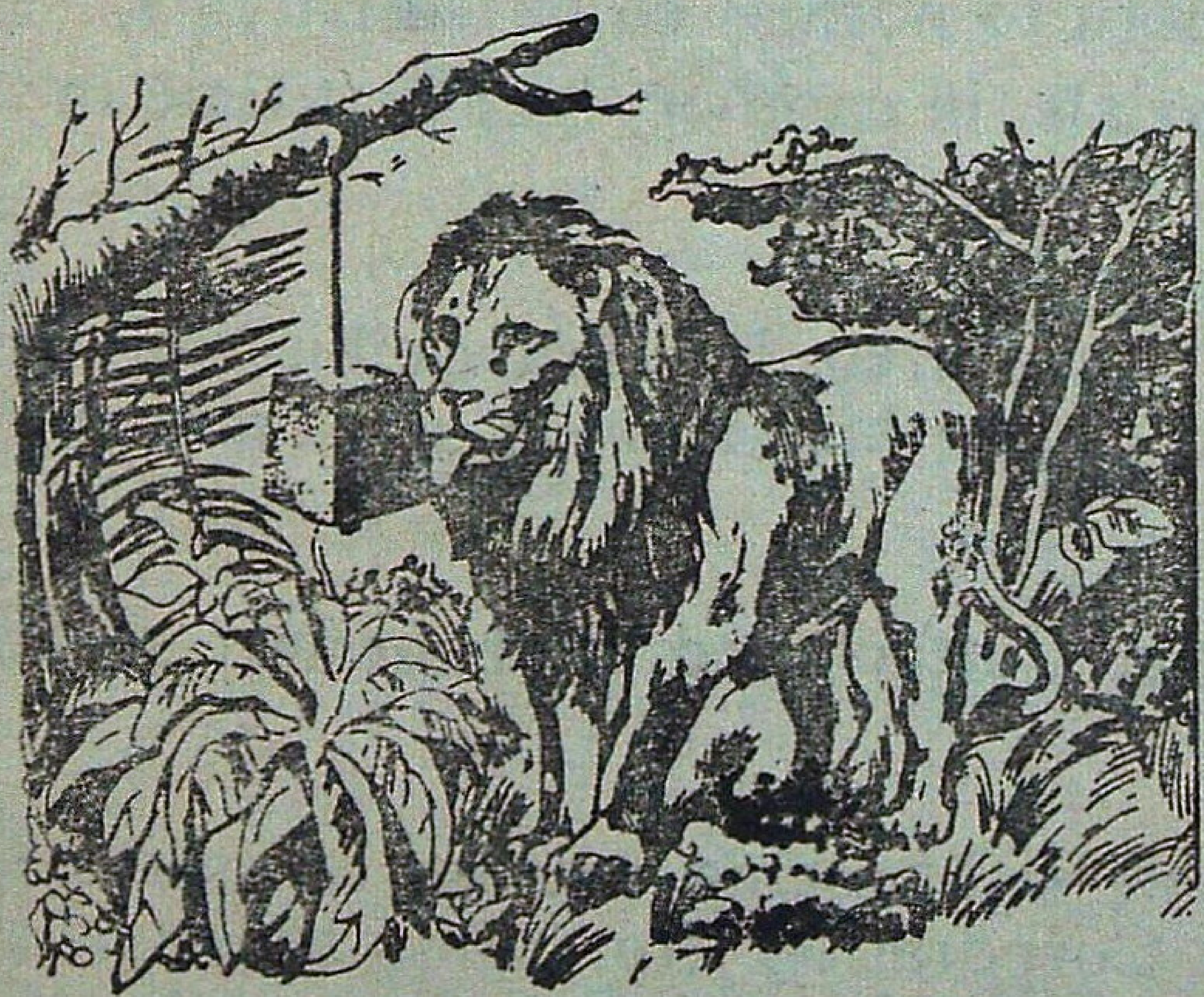
Regd. Office :—
ITANGAR—79111
Distt. Sabansiri
(Arunachal Pradesh)

Head Office :—
P.O. Deomali-786629
Distt. Tirap
(Arunachal Pradesh)

1/83–12/83

MONOLICK® SALT LICK

makes wild Animals Healthier.



In natural habitat wild-life often suffers from inadequacy of salt in the forests. Animals lick ground or impure rocks for salt intake and develop diseases. Result – high mortality.

Now, world over, SALT LICKS have been designed to supplement this deficiency. India and in adjacent countries, **MONOLICK SALT LICK** has long been introduced, is highly effective for disease prevention, and for growth stimulation

* The easy and economical way of providing primary nutrient 'pure salt' to animals.
* Picking points for locating wild animals.
* Harnessing licking habits for health and lower mortality rate.

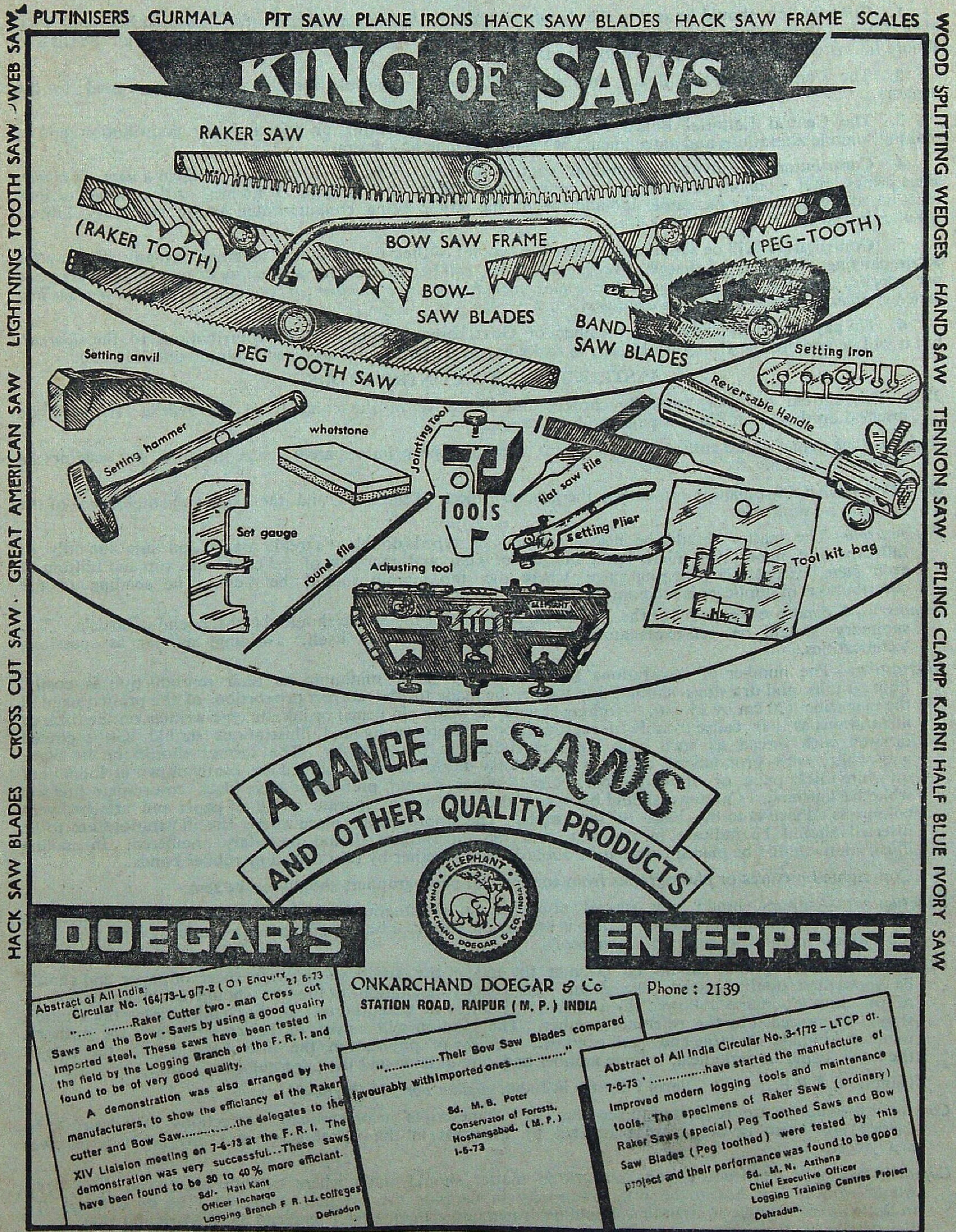
Manufacturers

MUHANA COMPANY

SHEGAON (C. Rly.) India

MUHANA

Goldfields


PUTINISERS GURMALA PIT SAW PLANE IRONS HACK SAW BLADES HACK SAW FRAME SCALES
WOOD SPLITTING WEDGES HAND SAW TENNON SAW FILING CLAMP KARNI HALF BLUE IVORY SAW
HACK SAW BLADES CROSS CUT SAW. GREAT AMERICAN SAW LIGHTNING TOOTH SAW /WEB SAW
KING OF SAWS
RAKER SAW
(RAKER TOOTH)
BOW SAW FRAME
(PEG-TOOTH)
BOW-SAW BLADES
BAND-SAW BLADES
PEG TOOTH SAW
Setting anvil
Setting Iron
Reversable Handle
Setting hammer
whetstone
Jointing Tool
Tools
flat saw file
Set gauge
round file
Setting Plier
Tool kit bag
Adjusting tool
A RANGE OF SAWS
AND OTHER QUALITY PRODUCTS
ELEPHANT
ONKARCHAND DOEGAR & CO. INDIA
DOEGAR'S ENTERPRISE
Abstract of All India Circular No. 164/73-L g/7-2 (O) Enquiry 21 6-73
"..... ....Raker Cutter two-man Cross cut Saws and the Bow-Saws by using a good quality imported steel. These saws have been tested in the field by the Logging Branch of the F. R. I. and found to be of very good quality.
A demonstration was also arranged by the manufacturers, to show the efficiancy of the Raker cutter and Bow Saw...............the delegates to the XIV Liaision meeting on 7-6-73 at the F. R. I. The demonstration was very successful...These saws have been found to be 30 to 40 % more efficiant.
Sd/- Hari Kant
Officer Incharge
Logging Branch F R. I.E. colleges
Dehradun
ONKARCHAND DOEGAR & Co
STATION ROAD, RAIPUR (M. P.) INDIA
Phone : 2139
"...............Their Bow Saw Blades compared favourably with imported ones..............."
Sd. M. B. Peter
Conservator of Forests,
Hoshangabad. (M. P.)
1-5-73
Abstract of All India Circular No. 3-1/72 - LTCP dt. 7-6-73 '...............have started the manufacture of Improved modern logging tools and maintenance tools. The specimens of Raker Saws (ordinary) Raker Saws (special) Peg Toothed Saws and Bow Saw Blades (Peg toothed) were tested by this project and their performance was found to be good
Sd. M. N. Asthena
Chief Executive Officer
Logging Training Centres Project
Dehradun.

RULES OF CONTRIBUTIONS

1. Contribution should be sent to the Honorary Editor, *Indian Forester*, Forest Research Institute, P.O. New Forest, Dehra Dun, or to any Member of the Board of Management or Central Editorial Board and should be written legibly in ink *preferably* typed.

2. The Central Editorial Board does not hold itself responsible for the opinions expressed by the authors.

3. The Central Editorial Board reserves the right of accepting or rejecting any contribution and of making suitable alterations and amendments, without assigning any reason.

4. Contributors are invited to sign their contributions in preference to affixing to them a *nom de plume*, since professional opinion naturally carry more weight when their author is known. All communications must be authenticated by the name and address of the writer being communicated to the Honorary Editor, whether intended for publication or not.

5. Contributors will be supplied with 30 extra copies of their contributors, together with any illustrations accompanying them, free of charge. Additional copies will be charged for at the rate of twenty paise per page per reprint. *Contributors desiring extra copies should state the number of reprints required when sending articles, otherwise they will not be available.*

6. No payments will be made to members of Govt. organisation for their contributions to the *Journal* but it will be open to the Honorary Editor, to make payments for articles accepted from the outside public.

INSTRUCTIONS TO CONTRIBUTORS

Title—This should be brief, carefully chosen, and indicative of the contents of the article. It should be inserted on the top of the first page in block capitals.

Authors—The name of the author and his status should appear immediately under the title, but need not be entirely in capitals.

Introduction—An introduction presenting the general object of the work, and the scope and importance of the problem is, desirable.

Presentation—The matter should be neatly written, or typed double or treble spacing, on one side only of fullscape size paper with a left hand margin of 4 cm and margins of 2.5 cm at the top and bottom of each page except the opening page where the top margin should be 4 cm. The sending of the contributions in duplicate is recommended.

Summary—A condensed account of the important contents of the article should be at the end of article. The summary should be self-explanatory, complete and clear in itself, avoiding, as far as possible, technicalities.

Illustrations—The number of illustrations should be kept at a minimum as their reproduction is costly. Photographs and drawings should, if possible, be made to the correct proportion of the printed page of the magazine (20 cm by 15 cm). Nothing should be written in pencil or ink, or type-written on the back of illustrations as they cause trouble in reproduction. Photographs and illustrations should not be pinned or swen with thread as such pine holes reproduce in photography. The former should be in black and white, with pronounced contrasts and glossy finish; the later should be neatly drawn in Indian ink on white thick paper or drawing paper. Graph paper should preferably have black co-ordinate line son white background. Captions should be typed or written on separate strips of paper and attached with colourless adhesives to the back of the prints. The approximate place where the illustrations are to be inserted should be indicate in the text, and the illustrations should be serialy numbered. In mailing illustrations should be placed between cardboards held together by thin thread or rubber bands.

Copyrighted pictures or photographs from commercial photographers should not be sent.

Punctuations—Authors should pay special attention to punctuation as this greatly aids the reader in understanding the author clearly; if this is left to the editor, a wrong punctuation made by him may alter the author's intended meaning of a sentence.

Citations—The Bibliography should be given at the end of the article on separate sheet of paper and should be typewritten double-spaced throughout. Reference to a citation in the text should be made by means of the author's name followed by a reference number in parentheses. In the bibliography the citation should be preceded by the reference number. The citation will consist of the serial number, the author's name and initials (in large and small capitals), the year of publication, the title of the article, the title of the book, paper or periodical, volume number and date of issue and the page numbers, thus:

Hamilton, A.P.F.,: 1947. Farm Forestry in India. *Indian For.*, 74 (3), 84–88

Corrections—Authors are requested to see that their typescripts incorporate all corrections they desire to be carried out as no revisions are permitted by the press in the proof stage and any resetting involves heavy cost.

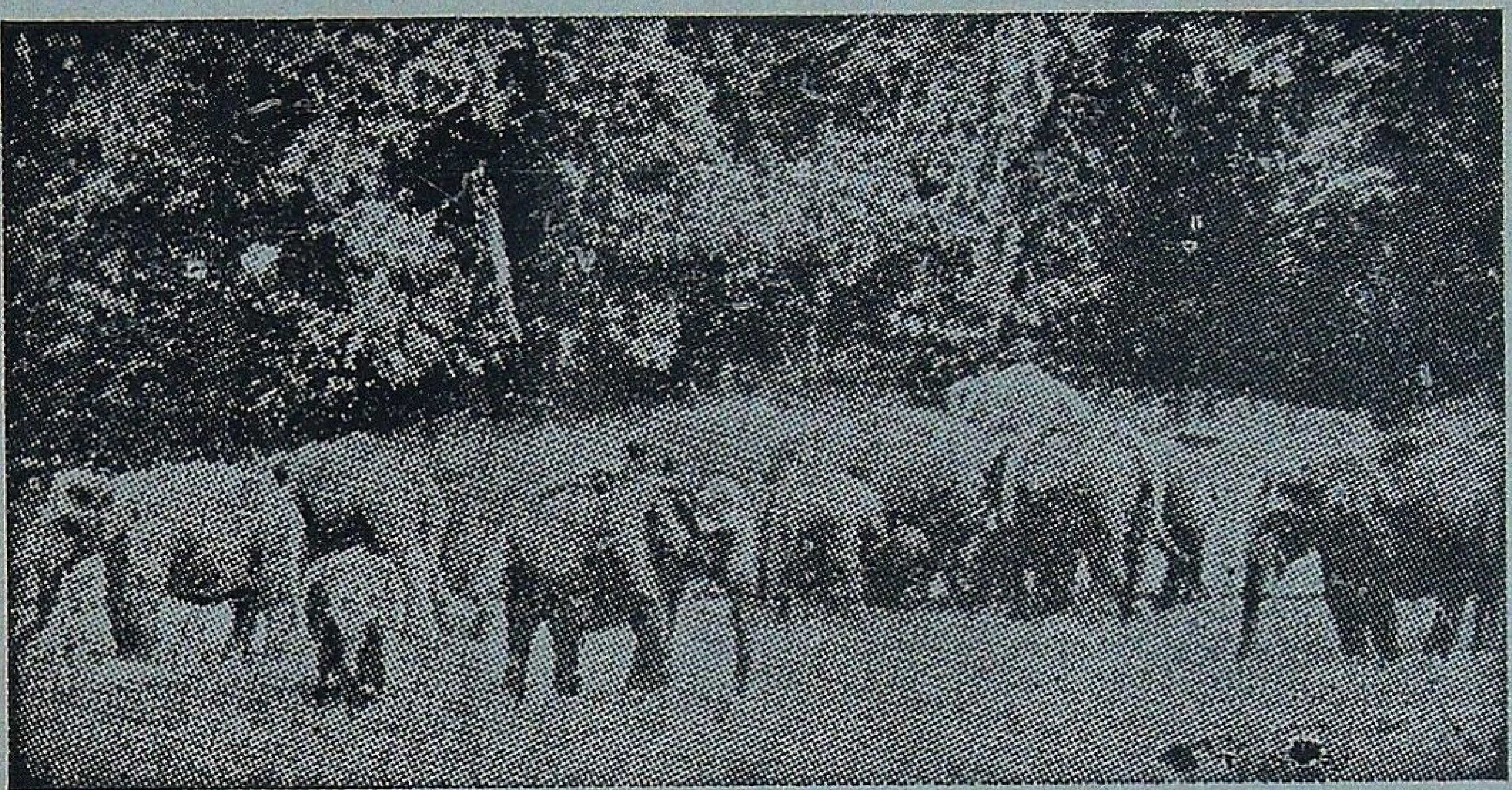
Capitals—Normally, typewritten or handwritten matter should show where capitals are to be used. If a whole wordor line has to be printed entirely in capitals the original should also be so written. To indicate italics a single straight line should be drawn under the matter concerned in the original text. For detailed instructions see the editorial in the *Indian Forester* of May, 1950.

VISIT: PERIYAR TIGER RESERVE

THEKKADY (KERALA STATE)
(OPEN ALL YEAR)

OBSERVE

Elephants, Gaur, Sambhar Leopard, Wild Dogs, Black Langur, The Giant Malabar Squirrel, Birds and other indigenous Fauna.



Hotels :
Western Style—Aranya Nivas
Indian Style—Periyar House.
(Accommodation in Hotels reserved by Managers)
†Furnished Forest Rest Houses at Thannikudy, Mullakudy and Manakavala.
†Motor Boats available for most enjoyable cruise in the lake.
†Elephant rides.
†Approachable by Air or Rail up to Cochin or Madurai.
Distance to Thekkady by road is 190 KMs. from Cochin, 145 KMs. from Madurai and 110 KMs. from Kottayam.

For further particulars contact :—WILD LIFE PRESERVATION OFFICER
Thekkady P.O., (Kerala)
Telephone : KUMILY 27

2/82—1/83

FOR ROPING AND PLANTING TREES

POLYTHENE BAGS

GUSSETTED-PERFORATED OR PLAIN

Contact for Immediate Supply

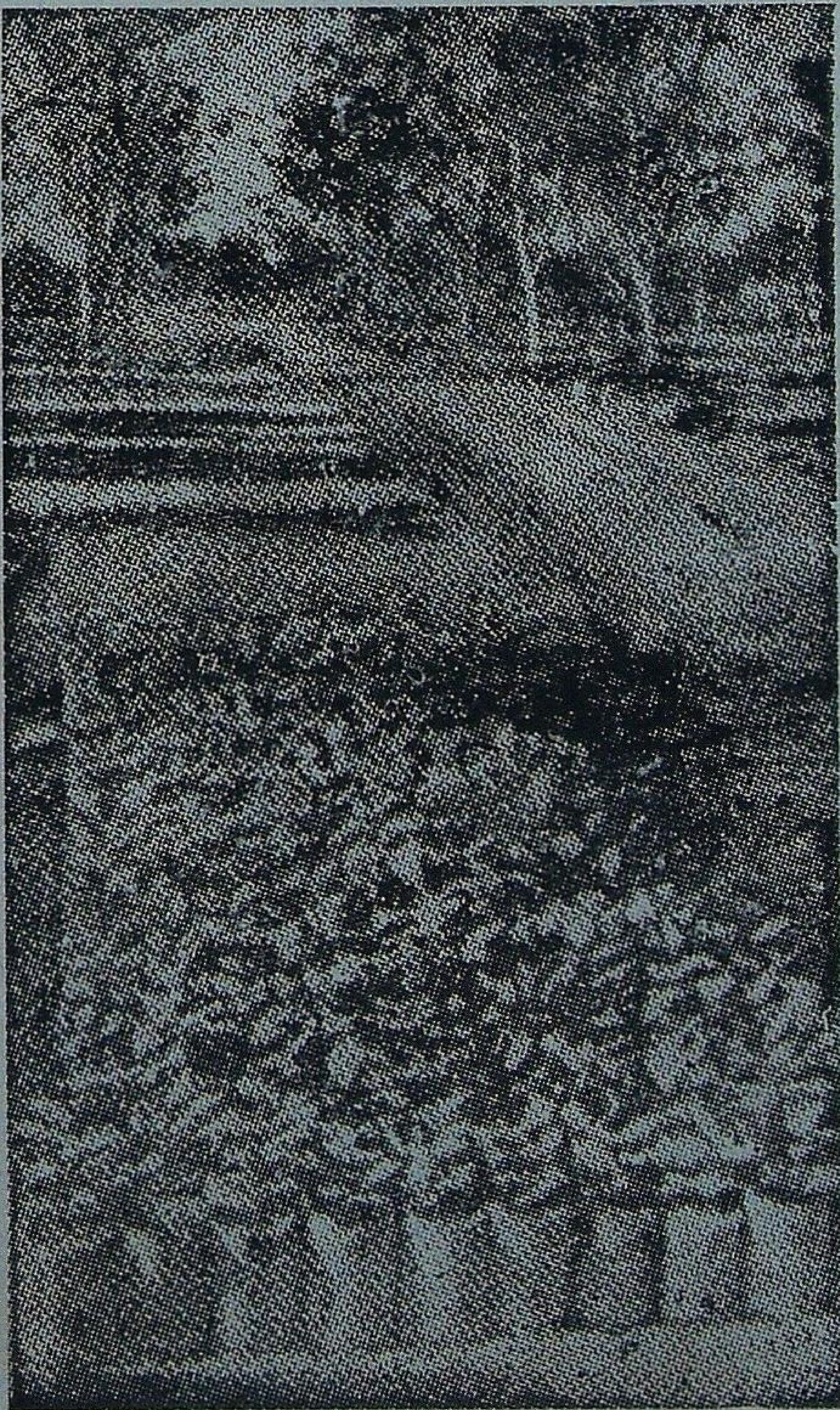
KANPUR PLASTIC COMPANY

111/423, Ashok Nagar, KANPUR—208012

Phones { Office : 43721 & 44992
Resi. : 81569   Gram—KANPLASTIC
Fac. : 44993   Estd.—1956

ALL SIZES OF POLYTHENE BAGS IN REQUIRED GAUGE & SPECIFICATIONS AVAILABLE

1/83—12/83



THE

INDIAN FORESTER

VOLUME 109 JUNE, 1983 NUMBER 6

SUSPENSION BRIDGE MADE OF CANE OVER A HILLSTREAM IN WEST KAMENG DISTRICT, ARUNACHAL PRADESH
Photo—Pratap Singh ... Front Cover

CONTENTS

ARTICLES

PLYWOOD INDUSTRY OF INDIA AND EXPORT PROSPECTS.
S.R. Sagar and M.Y. Ansari 339

EFFECT OF N, P, K FERTILIZER APPLICATIONS ON GROWTH OF *PINUS CARIBAEA* SEEDLINGS.
D.C. Agrawal, S.K. Rawal and H.P. Bhatnagar 349

GERMINATION OF *POPULUS CILIATA* SEED AS INFLUENCED BY MOISTURE STRESS. R.V. Singh and Virendra Singh 357

HAZARD REDUCTION FOR FOREST FIRE PREVENTION. P.M. Sangal ... 359

RETURN OF NUTRIENT BY THE LEAF-LITTER OF BLUEGUM (*EUCALYPTUS GLOBULUS*) AND BLACK WATTLE (*ACACIA MEARNSII*) PLANTATIONS OF NILGIRIS IN TAMIL NADU
C. Venketaramanan, B. Haldorai, P. Samraj, S.K. Nalatwadmath and C. Henry 370

SUPPLEMENTING RESIN PRODUCTION BY TAPPING BLUE PINE (*PINUS WALLICHIANA*). N.K. Gulati, R.R. Fernandez and P.S. Payal ... 379

FOREST VEGETATION SURVEY AND CLASSIFICATION WITH SPECIAL REFERENCE TO SOUTH INDIA
S.K. Sharma, M. George and K.G. Prasad 384

A NOTE ON PHYSICAL AND MECHANICAL PROPERTIES OF *ACACIA MEARNSII* (SYN. *ACACIA MOLLISSIMA*) FROM TAMIL NADU. V.K. Gupta and M.C. Kukreti 395

USE OF KENAF AND ROSELLE AS PAPERMAKING FIBRES.
Y.K. Sharma, S.N. Dhoundiyal and G.M. Mathur 401

GRASSES OF PUNJAB—PART I M. Sharma 407

RESEARCH NOTE 417

LETTER TO THE EDITOR 420

GAZETTE NOTIFICATIONS 422

CENTRAL EDITORIAL BOARD

K.M. TIWARI, I.F.S. *(President)*, O.N. KAUL, I.F.S. *(Hony. Editor)*,
C.S. Kirpekar, I.F.S., M.M. PANT, I.F.S

Edited by O.N. Kaul, I.F.S. Honorary Editor, Indian Forester (Director, Forestry Research, Forest Research Institute & Colleges, Dehra Dun), Published & Printed by N.K. Mathur, I.F.S., Business Manager, Indian Forester (Officer-in-Charge, Central Documentation & Library Branch, Forest Research Institute & Colleges, Dehra Dun) and Printed at Print World, Dehra Dun.

Registered No. **D.N. 36**